DOCTOR OF PHILOSOPHY

An exploration of design strategies and methods in the development of digital interactive television for older people

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Declaration by the candidate

I declare that I am the author of this thesis; that, unless otherwise stated in the text, all references cited have been consulted by me; that, except for those parts of work which are declared in this thesis to be based upon joint research, the work which this thesis records is mine; and that it has not been previously presented or accepted for a higher degree.

Mark Rice

June 2009

Declaration by the supervisor

I declare that Mark Rice has satisfied all the terms and conditions of the regulations made under Ordinances 12 and 39; and has completed the required 9 terms of research to qualify in submitting this thesis in application for the degree of Doctor of Philosophy.

Professor Alan Newell

June 2009

Abstract

Amongst a changing digital landscape, the proliferation and diversification of technology in the home has meant many underlying principles taken from the workplace now require new perspectives, in order to accommodate for the private and discursive practices associated with domestic living. This represents significant issues in the elicitation of reliable and appropriate feedback from older adults, who have not grown up with the same familiarity and understanding of present day user interfaces as younger generations. More specifically, not only in terms of the development of ill-defined technologies (and their potential functions) more suitable to this age group, but also those people who lack the experience and prior knowledge to easily identify, understand or discuss the potential uses of new systems.

This thesis contributes to the challenges of embracing reluctant and inexperience older people within the development of new and emerging domestic technologies, in order that applications are more appropriately designed for this widely diverse and heterogeneous user group. Focusing on the digital interactive television (DITV) platform, five interrelated studies are presented within requirements gathering and early evaluation phases. As a starting point, identifying the constraints of traditional interviews and focus groups, the research explores a series of methods and techniques that aim to bridge disparities in conceptual thinking, by allowing older users to understand the potential utility of digital technology. In using visually creative ways to articulate and self generate ideas, these solutions are first proposed through the use of Forum Theatre, and later refined through a small set of paper prototyping sessions. As an outcome of early research findings, a more sustained series of hi-fidelity prototypes were developed to investigate more meaningful navigation approaches in support of social application areas. The results illustrate important limitations in observing and evaluating user behaviour, in an attempt to identify the potential for more tangible interactive concepts based on the theme of continuity.

Drawing from conclusions, in having successfully demonstrated strengths in the methods

applied, this thesis argues further research is required to establish a holistic framework in working with older adults. A number of key areas for future research have been identified, including the possibilities for building on the interface concepts developed using alternative state of the art devices.

Associated publications

The following publications are related to this thesis, and have contributed to a number of the chapters in this body of work.

Mikulecká, J., Margarone, M., Bellotti, F., Hofshi, N., Vitek, P., **Rice**, **M**., Mikovec, Z., Schut, M., and Maly, I. (2008) *SoA and guideline for technology, UI and cognitive content report*. Vital Mind IST- 215387.

Rice, **M**., and Alm, N. (2008) Designing new interfaces for digital interactive television usable by older adults. *ACM Computers in Entertainment*, 6(1).

Rice, **M**., and Carmichael, A. (2008) *Discovering older adults' user perspectives on undefined TV applications*. Inclusive interactive television: Setting the agenda for innovative research. Workshop at the 6th European conference on interactive television, Salzburg, Austria.

Rice, **M**., and Carmichael, A. (2007) *Effective requirements gathering for older adults*. SIGACCESS newsletter, June 2007.

Rice, **M.**, Newell, A., and Morgan, M. (2007) Forum theatre as a requirements gathering methodology in the design of a home telecommunication system for older adults. *Behaviour and Information Technology*, 26(4), pp. 323-331.

Rice, **M**., and Alm, N. (2007) *Sociable TV: Exploring user-led interaction design for older adults*. Proceedings of the 5th European conference on interactive television, Amsterdam, pp. 126-135 (**won 'Finalist' award)**.

Carmichael, A., **Rice**, **M**., Sloan, S., and Gregor, P. (2006) Digital switchover or digital divide: A prognosis for usable and accessible interactive digital television in the UK. *Universal Access in the Information Society*, 4(4), pp. 400-416.

Carmichael, A., **Rice**, **M**., and Sloan, S. (2006) *Inclusive design and interactive digital television: Has an opportunity been missed?* Proceedings of the 3rd conference on universal access and assistive technology, University of Cambridge, pp. 59-70.

Carmichael, A., **Rice**, **M**., and Sloan, D. (2005) *Digital interactive television in the UK: is the opportunity for 'inclusivity' being missed?* Proceedings of the Accessible design in the digital world conference, Dundee, published on CD-ROM.

Rice, M. (2005) *Towards a 'communication aid' to support social interaction for older people via interactive digital television*. Doctoral Consortium, Accessible design in the digital world conference, Dundee, published on CD-ROM.

1. Designing digital technology for domestic spaces

1.1 Introduction

The rapid growth of information and communication technologies (ICTs) and the diversification of usage domains and types of end users have required the examination of new and expanding ways of engaging with computational systems. This has resulted in attempts to consider interaction beyond the limitations of the virtual desktop metaphor and WIMP[1] interfaces, which require high quality graphics, adequate screen space and finely tuned motor skills to control and select cursor movements (Baber and Baumann 2002). Notably, this has a particular precedence in exploring new paradigms of ubiquitous, persuasive and everyday computing, more suitable for the specifications of specialised, 'non-desktop' forms of *information appliances*[2]. As such, within this fragmented and multidisciplinary field, an emerging area of interest has been the broad development of ICT technologies, which, in principle at least, have been designed to support the everyday interactions of domestic life.

According to Bell et al. (2005) Western industrialisation and the adoption of domestic technologies have extended the home as a site of production and mediated consumption. Described as a sanctuary of family life, the home as a social and political space full of *"emotional meanings and symbolic resonances"* (Bell et al. 2005, p.150), has been transformed by a host of domestic devices (e.g. the vacuum cleaner, iron, washing machine and telephone), which controversially have increased the time management, efficiency and monotony of housework, as well as attributed to a noticeable shift in the division of household labour (Venkatesh 1985; Habib and Cornford 2001).

More recently, the rapid development of ICTs and the shrinking production costs of information

1 Windows, icons, menus, and pointing devices.

2 An information appliance is a particular type of everyday device designed to perform one or more specific functions related to information processing. Typically, it is designed for a high level of transparency, or low level of experience and commitment to operate (Sharpe and Stenton 2003).

appliances have identified the home as a prominent growth area in digital technology. The 'smart home', incorporating networked and interconnected technologies, has increasingly been a focal point of research in areas as diverse as ambient intelligence, home security, personal robotics and medical and rehabilitation care. Central to these emerging themes has been a push to use home-based assistive and augmentative technologies to support and monitor older, physically and cognitively impaired people, both to improve their quality of life (e.g. by reducing social isolation and enhancing day-to-day activities) and to limit long-term public healthcare costs. As such, robust communication infrastructures (both internally and externally) for networking physical devices and other related domestic appliances, dynamic enough to accommodate for a variety of users, are seen as a key element in the support of the *ageing in place* ethos. Focusing on older adults, studies have ranged from the use of home sensor-based technologies to support simple events and daily routines (Mynatt et al. 2001), including data mining and software-based learning programmes used to measure, monitor, detect and predict deviations in resident lifestyle behaviour (Augusto et al. 2005; Barger et al. 2005; Gil et al. 2007), to communication and conversation aids (including surrogate and artificial companions) used to facilitate aspects of social interaction (e.g. see Donaldson et al. 2005; Kriglstein and Wallner 2005; Sherwood et al. 2005).

In view of ever more immersive systems, the long-term impact of informed design for older adults is shaped by wider concerns over the complexity and amount of expertise required to use increasingly sophisticated computational systems in the home. For example, as technologies seamlessly fill domestic spaces, there is a danger that target users will increasingly find themselves in the position of 'systems administrator' over an accumulative assortment of interoperable devices (Edwards and Grinter 2001). This obviously raises a number of key questions over the usability and accessibility of systems with far fewer physical affordances, which form an integrated part of the fabric or domestic landscape of the home. These issues are particularly prominent among people with degenerative conditions, whose requirements will undoubtedly change over time (Dewsbury et al. 2001). The question of how technologies are

(and will be) actively incorporated into the practices of people's day-to-day lives is therefore an intricate and highly debatable one to answer.

1.2 Information and communication technologies in domestic spaces

Until recently, ICT systems were considered almost exclusively to fall within the domain of the work environment (O'Brien and Rodden 1997). Consequently, variations of domestic technologies in the home have drawn criticism in relation to a lack of theoretical and empirical grounding required to comprehensively observe and analyse their adoption and use (Venkatesh 1985; 1996). In particular, it has been recognised that few analytical tools are currently available for designers, beyond established approaches developed for the explicit and accurate completion of clearly specified tasks and work-orientated goals (Crabtree and Rodden 2004).

Consumer markets are complex and highly competitive. Whilst formal market research can be used to assess levels of satisfaction with commercially available products (Miles et al. 1992), arguably they provide little understanding towards the domestic behaviour of the social actors who inhabit these environments. One reason for this has been the very private and personal nature of the home, making it difficult to study from an outside perspective looking in. To illustrate, through exploring television consumption in the household, Ang (1992), in what she describes as traditional methods of gathering audience ratings (such as the diary and setmeter[3]), highlights the weaknesses of an industry's attempts to neatly 'streamline' and classify audiences into generalised patterns of media consumption and commodity. Both an over-simplistic and unrepresentative view (of what could be described as 'one dimensional' television viewing), these issues reflect the wider failures of a media industry unable to account for the active and discursive cultural practices of the consumer, which Ang (1992) argues, are beyond prediction and measurement.

Crabtree et al. (2001a; 2001b; 2001c), on the other hand, relate the problem to a lack of design

3 A setmeter is a measurement device attached to the television set to record channel pattern usage.

innovation (including appropriate methodological practices), which as a consequence has attempted to explore the home environment as something radical and new, rather than as an evolutionary space rooted in social and historical values. As such, technological perspectives driven by innovation and trends run the risk of developing solutions that are *"incompatible with the practical day-to-day circumstances of use"* (Crabtree et al. 2001b, p.1). Consequently, it is argued that designing for the legacy of the home is not simply about the physical or technical development of systems, but also about understanding how they are irremediably bound to the social organisation of the activities and spaces they inhabit (Crabtree et al. 2001b).

In defining a framework for exploring the roles and patterns of ICT usage, Venkatesh (1996) and Venkatesh and Nicosia (1997) proposes the classification of managing household activities within various sub-environments as Leisure/Recreation/Entertainment, Social/Family Communication and Family Development/Well-Being. As part of this schematic model (see **Figure 1**), the household is separated into two components: 1) *social spaces* defined as the types of interaction and activities undertaken by its inhabitants (constructed through gender and generational differences), and 2) *technological spaces* defined as the configuration of interactive systems within the home. Household members are a key component of the model, as the activities performed in each sub-environment are determined by family needs and responsibilities, suggesting that these spaces are 'targeted' for particular use, based partly at least, on their technological functionality (Venkatesh and Nicosia 1997).

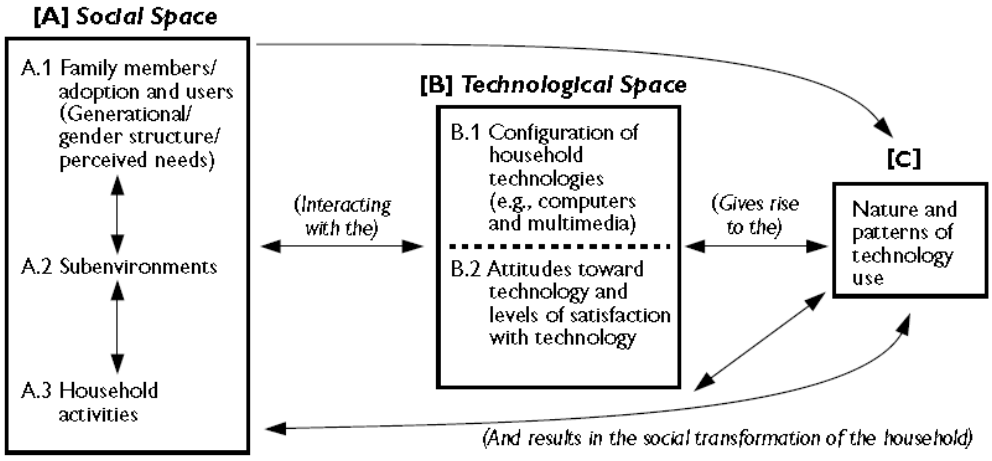

Figure 1: Example of household structure and technology use (Venkatesh 1996)

Alternatively, in exploring distinctions between the home and workplace, while increasingly interchangeable (given the variations of lifestyles and types of work achievable at home), domestic activities are drawn and managed within household boundaries. In other words, related to factors such as gender, income and social structure (Felstead and Jewson 1999), technologies in the home can be perceived to be purposefully arranged to separate divisions of work from leisure. For example, studies of ICT usage (Ward 2005, p. 152) have identified an active separation of family from working life by household members, consciously employing strategies to physically and *"symbolically curb the presence of work"*. While for Felstead and Jewson (1999), these boundaries are described as being negotiable by family members, employing strategies that either invite or disclose the home from the outside world. Although not a clear-cut distinction, differences in motivational factors, processes and uses can be seen to make designing for the domestic, private sphere, a comparable, yet separate domain. Therefore, as distinct from production processes associated with technology at work, the consumption of consumer goods in the home are based far more on individual factors such as 'aesthetic appeal, fashion and self-image' (Hindus 1999), than on values and criteria primarily associated with 'capital production':

> *The problem here is that such things as 'production' and 'efficiency', which may themselves be construed of in terms of such concepts as 'plans and procedures', 'business processes', and 'workflow' along with a host of other formal analytic*

> *concepts that describe the organization of practical action in the workplace in accountable terms of capital production, do not apply to the organization of practical action in the home... The home is not characterized by a common orientation to a shared work objective – the production of commodity X or the delivery of service Y. Such an orientation is absent from the home (Crabtree and Rodden 2004, p. 192)*

As a result of these differences, media and communication studies have attempted to understand how enhanced and mediated ICT technologies are socially, culturally and symbolically structured into the practices of everyday life. Described as the *"taming of a wild animal"* (Berker et al. 2005, p.2), domestication, i.e. the integration of digital media into the household, is known to impact heavily upon the home's own social and economic order through a dynamic process where commodities are transformed and appropriated by the family to sustain a sense of autonomy and individuality amongst its members (Silverstone et al. 1992). Delving more deeply, these commodities are given meaning in accordance to the values and rituals of the home and are redefined to adhere to the established routines, gender patterns and aspects of social hierarchy (Ward 2005).

Further, according to Berker, the construction of the household means domestication is not just about *"adapting technologies to people, but also about people creating an environment that is increasingly mediated by technologies"* (2005, p.3). The process of consumption is therefore one of *"sense making"* (Berker et al. 2005, p.7), as objects ascribe and gather meaning from their contextualised environment. In understanding the domestication concept, Silverstone et al. (1992) describe of the *double articulation* of ICTs, both in terms of their material and functional roles as objects, and as a medium, the types of mediated messages they subsequently convey. Specifically referring to the work of Kopytoff (1986), they emphasise how, more than static objects, these commodities (as technologies) can also be perceived to acquire *biographies* or *life histories*, rich in social and cultural meaning, appropriated through the ownership, use and values that become associated with these everyday things (Silverstone et al. 1992).

Conceived of as being part of a complex *transactional system*, the interrelated exchange of media from a public (formal economy) to a private (domestic) sphere set with different values and principles of exchange has been described by Silverstone et al. (1992) as being part of the *moral economy of the household.* This process, originally defined in four stages, includes:

- **Appropriation**: the transition of a sold object from being a commercial commodity to owned artefact.
- **Objectification**: the arrangement and physical display of an artefact to reflect the values and *aesthetic rationality* of the home.
- **Incorporation**: the functional usage of an artefact, which may be intentionally different from what it was originally designed for.
- **Conversion**: the relationship between the artefact and its wider social status within the outside world.

This research provides a solid framework for exploring the roles of emerging technologies, such as digital interactive television, which will be introduced and further investigated in **Chapter 3** of this thesis.

1.3 Design approaches

In view of the complexity of determining the domestication and use of technology in the home, the phenomena of rationalities, procedures and efficiencies found in the masculine structure of the workplace (Bell et al. 2005) need to be replaced by more stable and compelling techniques and approaches. Refining more orthodox and traditional forms of empirical evaluation primarily associated with measuring human performance, in order to gather new insights into the development of interactive systems appropriate for domestic life.

As human-computer interaction[4] (HCI) has evolved into what is now described as a *"boundless*

4 Commonly abbreviated as HCI, human-computer interaction is a multi-disciplinary field, concerned in the broadest sense, with understanding how 'users' interact with computer-based technology (Dix et al. 1993). Bridging across areas of psychology, engineering, computer science and design, it has

domain" (Barnard et al. 2000, p. 223), many underlying theories have come to rely on models of scientific research. However, some of these early models have shown noticeable deficiencies due to their attempts to single out cognitive processes, under very limited and isolated conditions, in comparison with what actually happens in the context of the real world (Rogers 2004). Given what Rogers describes as "[new] *opportunities for augmenting, extending, and supporting user experiences"* (2004, p. 89) a shift in thinking is required in the design process for end users and in tasks and system applications, when compared with more familiar, conventional engineering methods.

In terms of 'typical users', according to Rogers (ibid), the transfer of knowledge and the translation of research findings from one discipline to another in early information processing of HCI literature focuses heavily on adopting theories from psychology to explain phenomena in relation to cognition and user interface design. Using the example of the predictive model-based evaluation tool GOMS[5] (Goals, Operators, Methods and Selection rules), Rogers indicates the problems of selectively measuring user behaviour in complex everyday situations, where routine tasks are neither carried out independently nor sequentially. Given the flexibility of user behaviour and variability of how systems are used in the context of everyday life (particularly in the context of the home), it is argued that predictive models like GOMS analysis can only ever be a 'rough approximation' for subjectively determining the efficacy of computer-based systems. This is particularly evident in situations where factors determining the activities carried out are far more complex, and therefore more unyielding, than those ever modelled in a controlled environment of clearly defined work tasks (Rogers 2004).

Additionally, within the context of a work-based culture, the concept of usability has become strongly associated with task-oriented goals to 're-engineer' the business process, by reducing

emerged to encompass a wide range of perspectives, no longer limited to desktop technologies.

5 In short, GOMS is a predictive modelling technique used to describe the 'ideal' procedural knowledge required to achieve one or more task goals. Originally developed in the early 1980s by Card, Moran and Newell (1983), there have since been established a number of variations on the GOMS model (e.g. for more details see Kieras 2003).

labour and training costs of new systems and contributing towards improved productivity and organisation enhancement (Preece et al. 1993). However, this traditional 'task performance model' takes a very limited view of the cognitive and physical demands of the user (Jordan 2000). As a consequence, usability approaches to measuring task performance do not necessarily address the array of activities in the home, which in turn go far beyond aspects of efficiency and ease of use, towards much broader concepts of enjoyment, fun, pleasure and creativity (Jordan 2000; Monk 2002; Preece et al. 2002).

Interdisciplinary fields, such as Computer-Supported Cooperative Work (CSCW), are heavily focused on areas of workflow management, document sharing, process and task models (e.g. see Olson and Olson [2003] for a more detailed description of the literature), while engineering anthropometry[6] and the collection of anthropometric data (such as seating, visual display, position of controls, lighting, noise levels and other physical characteristics) from corresponding populations have centred on human performance in the workplace. In both cases, focus is driven by explorations of the computer workstation and the complex relationship of social interaction, job performance and (again) organisational structure at work. Related mental representations include goals, sub-goals and conceptual models directed towards supporting the desktop metaphor. User interfaces typically employ dialogue and hierarchical menu styles of interaction, primarily designed for the completion of predetermined and highly delineated tasks. This is reflected in mass-market applications like word processors, spreadsheets, databases and other information oriented applications, applying direct manipulation techniques to support input devices, such as the high precision mouse. Requiring a high level of skill and computer competency, this abundant use of the desktop metaphor has left a dry yearning for more appropriate design solutions for the home:

> *The desktop metaphor might once have been the perfect answer to the question how to support on a monitor screen professional users in an office environment, but the folders, windows and the trashcan metaphor have nothing to do with sailing,*

6 The study of anthropometric data (i.e. the measurements and dimensions of the human body) and how this relates to the design and ergonomics of new products.

> *broadcasting, being ill or having your car mended in a garage. Still, for some reason, there appears to be a strong urgency to get this office metaphor implemented in virtually every thinkable domain (Rakers 2001, p. 35)*

Furthermore, in acknowledging that ICTs are well established beyond the confinements of the workplace, there is a requirement for more radical thinking about the graphical user interface and how technology is infused into our everyday lives (Gaver 2002). Recognising that the context of behaviour and experience is changing more profoundly than ever before, enormous variations in domestic living indicate that the situated meaning of technology requires new levels of transparency to capture the rich context of individual and social activities (Sharpe and Stenton 2003). Contrary to the PC model, this includes how information appliances, restricted in focused attention and technical functionality, can capture personal attributes like playfulness, curiosity or wonder (Gaver 2002; Sharpe and Stenton 2003).

To date, an increasing number of domestic studies have applied 'ethnography-type' techniques to explore descriptively the situated and contingent role of technology in the home. Originally designed to understand the workplace (see Suchman 1995), a range of data-in-situ methods (e.g. observation activities, interviews and self-reporting techniques) have been used to describe everyday experiences.

Extending arguments for ethnography research as a substitute for more quantifiable means of measuring audience behaviour and media production and consumption patterns in the home (Morley 1992), a number of fieldwork studies have been undertaken to gather detailed descriptions on the roles of technology in everyday practice and the complexity of designing for this environment. These have largely centred on exploring small family units over relatively short periods of time to determine aspects of the social organisation, routine behaviour, family management and ownership of activities (O'Brien and Rodden 1997; O'Brien et al. 1999). Hughes et al. 2000, for example, have applied the findings of ethnographic studies as a means of

establishing design patterns to structure and inform new design solutions associated with domestic living, while more recently, re-evaluating family structures in the home, Taylor et al. (2008) have explored the unplanned tasks associated with 'pottering' (i.e. mucking about or idly spending time). Integrating the use of informal interviews, observations, and video capturing facilities using disposable cameras, participants were asked to describe and document these serendipitous activities. Acknowledging the difficulties of engaging with people in the process of pottering, Taylor et al. (2008), like much of the preceding ethnographic fieldwork previously reported, reflect on the absence of more appropriate methods to explore activities that lack a more 'structured arrangement of time'. Reverting back to the distinction between work and leisure-based tasks, in what Iversen et al. (2004, p. 174) describe as a *"complex constellation of more or less interconnected and interdependent technologies… that are changed and replaced in an ongoing movement between different technological, social and environmental settings*", highlight the requirement for more relevant approaches to inform design. This concern for more dynamic styles of investigation has long been an important focal point in understanding media audiences:

> *The world of everyday life is not one which can be satisfactorily viewed through a single pair of spectacles, or from a single position. It requires varieties of distance, magnification and position, and it requires to be understood as the dialectical product of inside and out: of biographies, personalities, meanings, actions, spaces, times, opportunities and material constraints (Morley 1992, p. 184)*

As a result, amongst an increasing interest in smart home technologies and the technical development of being able to measure aspects of physical behaviour in an experimental setting (see **Section 1.1**) has been the incorporation of participatory styles of practice to engage more successfully with various stakeholder groups. These have included the use of multi-method approaches (including *in-situ*) that combine aspects of observation, interview and prototype techniques to investigate the design of digital artefacts in the home (e.g. see Westerlund et al. 2003; Schmidt et al. 2007). Originally stemming from Scandinavian projects like UTOPIA[7] that

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investigated how the introduction of computer-based systems could democratically improve working practices of a skilled, traditionally craft-based workforce (Ehn 1993), participatory design (PD), as a process, has the advantage of not being limited to a particular technique, user group or technological domain. Nevertheless, against an extensive body of literature purposely exploring user involvement in the co-development of computer supported work, of the few studies employing PD in a domestic context (such as those previously listed), by and large they are vague in reporting their methodological analysis.

In spite of this, some success in this area has come from the work of Baillie et al. (2003) in exploring more novel approaches during requirements gathering and analysis. Concentrating on working with participants in their home settings, Baillie et al. (2003) builds on a number of techniques to explore current and future applications. Notable examples include the use of *Technology Tours,* in which a researcher is shown around the home by a family member, specifically to describe the location or social use of situated technologies. A technique that has been briefly reported by Blythe et al. (2002) in combining its use with other interview approaches, for Baillie et al. (2003) the research outcomes were refined further through additional methods. These included brainstorming and self-reflective periods in which participants were asked to creatively stick paper notes on household objects describing desirable or future uses. Given the trial and error nature of the studies, a number of practical limitations in their structure and implementation were identified. This included participants' willingness to open up their home as a private space to an outside researcher.

In addition, linking many researchers work over the last decade has been the use of probing tools to formulate ways of opening up the design process, by critically attempting to elicit new insights into users' thoughts, behaviour, aspirations and needs (e.g. Gaver and Dunne 1999; Gaver et al. 2004; Hutchinson et al. 2003). In bridging areas of social science, engineering and design, rather than focusing on a quantifiable scientific approach, (which has been described as being implausible given the unclear nature of these studies [Gaver et al. 2004]), a more

subjective, informal view is taken towards the difficulties of communicating with people at a distance. Amongst the various methods applied, examples have included *technology probes,* which have been used to inform artists and designers about the integrated and contextual use of technologies within household practices, such as to facilitate aspects of social communication (Hutchinson et al. 2003), and *cultural probes* (although not a clear cut distinction) to reveal and capture how life experiences and cultural differences inspire and enrich technological uses (Gaver and Dunne 1999; Gaver et al. 2004). Interrelated, there have also been attempts to combine elements of cultural probing with more conventional ethnographic techniques, in what has been referred to as *domestic probes* (Hemmings et al. 2002).

Yet, despite their increasing popularity, in what Gaver et al. report as their "*many layers of influence and constraint*" (2004, p. 55), the intentional ambiguity of probes in communicating with strangers has meant their interpretation is not without some degree of speculation and uncertainty. Openly aware of the elusive nature of the data obtained, such approaches are limited in their ability to rationalise more factual information. Nevertheless, perceived as being a lucrative means of evoking new design questions, Boehner et al. (2007) are mindful of studies that have attempted to use 'hard science' to try to validate the probing method. In what they describe as the dangers of probes losing their evocative qualities, concern is drawn towards the wider issues of researchers adopting techniques without fully understanding the implications of use. More so, within the context of this thesis, as one of a number of applied methods now used to study the home, their applicability is brought into question by the lack of studies working with more divergent groups, such as those with special needs. In HCI, this absence of understanding of the diversity within demographic populations is highlighted by the homogeneity often assumed of users, which Newell et al. (2008) describe as the treatment of 'static entities' in the user-centred design paradigm.

1.4 Catering for heterogeneity

One group where the disparity between assumed and actual heterogeneity is perhaps greatest is

older people. Amongst varying viewpoints to what now constitutes as being old (see **Chapter 2**), the important difference in designing for non-typical users can be reflected in the fact that many older people will have built up (and will relate to) a different knowledge base of norms, values and skills from younger generations, which are thought to be strongly formulated during adolescence (Docampo Rama 2001). This has a particular importance in the design of modern day information appliances, which for example, have replaced physical, mechanical controls (such as sliders, rotary or trigger switches) with hidden, uniform digital displays, consequently requiring more time, effort and attention to learn and self-operate (Baumann 2001). The familiarity of technologies associated with the electro-mechanical style (e.g. the television and telephone), have now radically been transformed in their complexity and functionality as software-style interfaces (Docampo Rama 2001). Consequently, many older people, who will have grown up understanding the electro-mechanical models of physical functions and tactile controls, are presented with significant challenges in their relearning of menu styles that dynamically (and often arbitrarily) change in functionality depending on their mode of interaction.

From a commercial perspective, the lack of understanding of generational differences and of user-centred needs is compounded by the behaviour of mass markets and a rationale that is still more influenced by trends in consumption - both in terms of demands and opportunities, and the related innovative capabilities of new technology (Miles et al. 1992). Baumann (2001) highlights this issue by what he deems as an ICT industry that still perceives the electronic or software interface as an 'add-on' feature, separate and secondary to the functionality of the system. As a result, it is argued that for businesses to gain the loyalty of older generations, they have to drastically re-evaluate the perceived values many older adults have of new technology, which is often based more on practical utility than novelty or originality (Coughlin 2007). This includes exploring reasons for non-adoption, which Coughlin argues, rather than due to technophobia *per se*, relates more to a lack of compelling reasons to buy.

As a result, based on the arguments presented in this chapter, there remains a lack of literature providing researchers with the necessary tools to gather requirements and explore the development of emerging domestic technologies. This issue is further complicated (and even less well defined) when considering heterogeneous population groups of older people, shaped by a wide range of different experiences and understanding of technology. HCI, although undoubtedly expanding, continues to orientate towards principles centred in the workplace. As a consequence, researchers can no longer rely on task-orientated models that fail to account for the diverse nature of non-desktop forms of interaction. Therefore, to ensure systems are relevant and appropriate to the target group, new avenues of research have to be ambitiously explored. In relation to the possible roles and potential benefits of domestic ICTs, this involves readdressing a design process that seeks to question the technological preconceptions of many older people, primarily by enabling them to become a core element in the requirements gathering and evaluation analysis. Highly undervalued, this thesis sets out to investigate some of these issues.

1.5 Aims of the thesis

Given the importance of the issues previously outlined, this thesis aims to investigate the key challenges of working with, and designing for, reluctant and technologically naive older adults within the context of developing non-desktop ICT technologies. As a basis for creative development, the research will focus on the emerging digital interactive television (DITV) platform. The main objective of this thesis is therefore to explore how to *genuinely* and *productively* involve and engage with older adults (60+) as relevant and active stakeholders in the design process, by encouraging them to take a more central role in the development of applications suitable to their age group. Consequently, the research questions proposed attempt to characterise the types of approaches that can help attain such understanding.

Question 1

How can designers and software professionals gather requirements from older people unaccustomed or reluctant to using 'digital' technologies, particularly in the design of new applications that are either undeveloped or undefined?

This is the principle research question of the thesis. This is dealt with in **Chapters 4-8**, which focus on the deployment of different methodologies within early requirements and evaluation phases. In particular, these chapters present a variety of ways to bridge gaps in technological understanding.

Question 2

What are the relevant constraints in working with older adults in the context of developing new applications?

In answering this question, information is collated throughout the thesis, in order to identify issues in engaging older people with new design concepts. The results are summarised in **Chapter 9**.

Question 3

What methods can be used with older adults to evaluate the intuitiveness of proposed design approaches to DITV services?

Motivated by the literature review and early research findings from **Chapters 3-6**, new navigational styles are explored to improve the interface design of DITV for older people. This question is investigated in **Chapters 7-8**.

The relationship between the research questions outlined in this chapter can be summarised as shown in **Table 1**.

Research question (Q)	Research challenge (C)	Chapters
Q1- How can designers and software professionals gather requirements from older people unaccustomed or reluctant to using 'digital' technologies, particularly in the design of new applications that are either undeveloped or undefined?	C1 - To develop methods to provide better insights into working with older adults in order they take a more central role in the design process.	4, 5, 6
Q2 - What are the relevant constraints in working with older adults in the context of developing new applications?	C2 - To identify and understand the weaknesses in traditional requirements gathering methods. C3 - To identify problems with inexperienced older peoples abilities to visualise or engage with new and unfamiliar design concepts.	2, 4, 5, 6, 7, 8
Q3 – What methods can be used with older adults to evaluate the intuitiveness of proposed design approaches to DITV services?	C4 – To explore the evaluation process of working with older adults in order to demonstrate the potential for more dynamic and creative means of interaction with 'social-based' TV applications.	3, 7, 8

Table 1: An overview of the research questions and research challenges

1.6 Contribution to knowledge

Firstly it is important to mention that although a considerable amount of software development was undertaken in the later stages of the project, this is not a software engineering thesis. In other words, all the software (and hardware) produced was designed to test out interface and navigational concepts with older users, to determine aspects of their ease of use and user engagement. This thesis is therefore not focused on the technical development of an interactive system, but rather requirements gathering methodologies and interface concepts that can be seen to formulate a basis for more quantifiable work in this area.

To summarise, the contributions of this thesis are:

- Firstly, from a *user perspective,* to present key factors in working with older adults, limited in the conceptual understanding and working knowledge of digital technology.
- Secondly, from a *methodological perspective,* to demonstrate the constraints of popular HCI practices like focus groups, compared to alternative approaches such as Forum Theatre, which involve more imaginative means of visually representing information in

early requirements gathering.

- Thirdly, from an *interactive perspective*, to develop a series of high-fidelity prototypes demonstrating the weaknesses of conventional metaphorical features on DITV, whilst at the same time, illustrating the potential benefits for new navigational styles based on the overarching concept of *continuity*.

1.7 Thesis structure

Having begun to set the agenda, **Chapter 2** focuses on the importance of older people as a heterogeneous group. It begins by outlining some of the implications of changing demographic populations. The chapter then goes on to describe some of the characteristics of ageing, reviewing traditional design practices, and related studies that have worked with older people. This is followed in **Chapter 3** by a more detailed exploration of the digital interactive television domain. It discusses the underlying technological infrastructure, as well as key challenges in designing for *television mediated interaction*. Describing some of the failings from early interactive systems dating back to the late 1970s, it concludes by illustrating some of the present flaws in 'inclusivity' for older people.

Chapters 4 to 8 present five interrelated research studies. The first study in **Chapter 4** demonstrates the use of a small set of traditional focus group and individual interview techniques to gather initial requirements for DITV applications. The results illustrate a number of shortcomings in bridging beyond familiar conceptual models. Given these constraints, **Chapters 5** and **6** document attempts to investigate more insightful means to engage with older people. Firstly, by developing a series of short plays, which were performed by professional actors to groups of older audiences, to evaluate the acceptability of a small set of applications. This is closely followed by a more focused study involving brainstorming and paper prototype techniques to identify participants understanding of a visual-based communication system. The conclusions drawn led to a more detailed phase of prototype and evaluation work.

Chapters 7 and **8** centre on pursuing issues in relation to two-way interaction and accompanying forms of navigation, exploring the constraints in more traditional forms of empirical evaluation. This involves a comparison of four different navigational layouts, designed to compare conventional with more experimental approaches. The results reveal a number of limitations in evaluating with older adults. Extending these research findings, a second stage of prototypes is developed to investigate the use of different forms of *animated transitions* (linking one interactive 'step' with the next). Further evidence is provided in determining the complexity of their effects, as well as the potential benefits to the target group. **Chapter 9** finally reflects on the conclusions of prior studies, including implications on, and directions for future research.

2. Ageing and technology

2.1 Introduction

Having described the complexity of understanding technology in the home, this chapter begins by exploring the importance of 'inclusivity' in terms of designing for older adults, arguing that despite a huge demographic market, this heterogeneous group remains an overlooked and poorly understood segment of the population. The chapter then moves on to describe some of the notable characteristics of ageing, finally drawing attention to the constraints and current weaknesses of user-centred methods in working with 'non-typical' users.

2.2 Age in an ageing society

> *To survive into old age is no longer an anticipated privilege for a small minority of people but an experience shared by the majority (Strokes 1992, p.1)*

The worldwide population is ageing. Present forecasts indicate that, by 2050, a third of the developed world will be 60 years old or over (Peace et al. 2007), rising to 2 billion people globally (Harper 2006). Within Western society in particular, there has been an absolute and proportionate expansion in population growth and ageing demographics. This is a somewhat different picture from the seventeenth century, when it was estimated that about one percent of the population reached an age of 65 years or older (Stuart-Hamilton 2000). Within the UK alone, the national population has trebled since the beginning of the twentieth century (Strokes 1992), during which time the number of those over 65 has risen to 16 percent (and rising) (United Nations 2007), with the largest growing population group, the over 80's, attributing to almost 4.5 percent of the national demographics (Office of National Statistics 2008).

In the West, increases in longevity in the *greying population* can be attributed to *relative growth*, a reduction in fertility rates which have been in decline across Europe since the nineteenth century (Murray 2008), and *absolute growth*, associated with lower mortality rates through

living in wealthier and more affluent societies. These changes are primarily supported by scientific advances in sanitation and medicine (i.e. use of antiseptic techniques, vaccinations and antibiotics), as well as more general improvements in working conditions and daily lifestyles, e.g. better dieting and physical exercise (Coleman 2003; Westendorp and Kirkwood 2007). Further, according to Phillipson (1998), the *reconstruction of old age* from post-war 1945 Britain can be contributed not only to advances in biomedicine and the dramatic expansion of pharmaceutical drugs, but also to the introduction of mandatory retirement and social rights in relation to health and well-being associated with the welfare state.

On both global and national scales, this demographic shift has had a profound impact upon social, political and economic institutions (Johnson 1993; Phillipson 1998). For example, beyond the stigma and ageist perceptions associated with getting old is the public expense of supporting adults in later life. The rapid expansion in population growth can be measured not only in terms of the financial costs required to adequately sustain retirement, employment, and social and healthcare systems principally funded by a diminishing younger workforce (which over the last 150 years has seen a dramatic reduction in the percentage of working hours in a lifetime, from an average of 33% in the 1850s, to just 7% in the 1990s [Midwinter 2005]), but also through the increased attention of human resources on local authorities to maintain the well-being of older adults within housing and social services. In the UK alone, Age Concern (2002) has estimated 6.8 million homes to be headed by someone over 60 years. This, in itself, is a reflection of the shift away from multi-generational households, and changes in family structure, size and kinship roles that have taken place over the past century (Harper 2006). As a consequence, many older adults now live and function independently (Johnson 1993). In particular, amongst different age groups, this change is most apparent amongst older women, who over the age of 65, are twice more likely to live alone than men of the same age (Office of National Statistics 2005).

Central to the breakdown of the family unit has been a push for technological innovation, not

only to meet the requirements of older users, but also to accommodate the range of heterogeneity within the wider population. This includes people with disabilities, of whom in Europe are estimated to be in the region of about 10-12% (European Parliament 2000). As such, ICTs are increasingly expected to have a strong impact upon the facilitation of healthy living, prolonged independence, autonomy, mobility and safety for older adults, particularly, for those housebound and mobility stricken, who are at an increased risk of social exclusion either due to chronic illness, disability and/or poverty (Mynatt and Rogers 2002; Morris et al. 2004). Related to the smart home issues as previously discussed in **Chapter 1**, these include trends to explore the use of technology in relation to healthcare, security and the monitoring of activities of daily living (ADL) for regular and predictable tasks (e.g. washing, going to bed, or having a meal), as well as communication prosthetics to accommodate cognitive dysfunctions, or interactive systems to extend social awareness and strengthen reciprocal lines of communication. These issues are particularly paramount in Western countries like the United States, where 80% of long-term care is undertaken by unpaid family and friends, rather than by trained medical professionals (Magee 2007).

Yet, despite strong indications of a shrinking youth market, as reported in **Section 1.5**, industries have been blamed for 'uniforming' older populations, rather than developing a rationale that offers a wealth of consumer products across a broad range of age groups (Coleman 2003). Apathetic approaches towards a more diverse marketplace are currently characterised by the synonymous design of products for both older and disabled consumers, as companies often fail to account for, on the one hand, differences, between self-perception, aspiration and need, and, on the other, design requirements between disabilities affected by age-related decline and those congenitally acquired from birth (Coughlin 2007). Furthermore, without accounting for variances in lifestyle, behaviour and (critically) human factors research in allowing for differences in age-related abilities, it is unsurprising that products catering for the older marketplace continue to stigmatise older users (Monk 2002). The typecasting of ageing technologies within the specialised and high-cost divisions of medical rehabilitation and,

specifically, assistive technology primarily designed to support 'patients' with special needs (Newell 2003), also means many 'healthy' adults are likely to reject their applicability (Carmichael 1999). More so, within the traditional divisions of medical and social care, the focus on degenerative conditions associated with the 'disabled' user overshadows those with more minor impairments (Manning et al. 2006) - the category within which many older people will fit. As such, the prominence of empowering older adults affected by illness and disability represents only one part of understanding how modern technology should support longevity through an array of lifestyles and different ways of living (Coughlin 2006).

2.3 Characteristics of ageing

Strongly related to the issues of the design of new interactive systems for older people is the importance of understanding the highly complex process of human ageing, and the impact this has on how older individuals develop strategies to compensate and accommodate the use of ICT technologies. Ageing can be understood as a biological degeneration of bodily functions related to a lifelong accumulation of genetic faults in cell and bodily organs, exacerbated by additional factors such as diet, lifestyle, illness and disease (Westendorp and Kirkwood 2007). Alternatively, it can also be understood in terms of physiological changes associated with sensory, cognitive and motor abilities, such as:

- *Vision:* changes include a decline in accommodation and visual acuity; reduction in the absolute diameter of the pupil; thickening and loss of discolouration and opacity of the eye's lens, resulting in changes in colour and depth perception; increased hypersensitivity to glare and brightness; and lower contrast and luminance thresholds (Stuart-Hamilton, 2000). Not only does this lead to increased scattering of light in the eye, with increased risk of impairment (Fisk et al. 2004), but also significantly to less light entering the eye's retina meaning that there are strong implications for the readability of low contrast displays (Carmichael 1999). Common visual impairments such as cataracts and presbyopia[8] are a prominent part of the ageing process, as a large

8 Correctable through eye surgery or the wearing of spectacles/contact lenses, *Presbyopia* is a

percentage of those people reported as being legally blind or partially sighted are over the age of 65 (Gill 2000).

- *Hearing:* changes include a marked increase in detection thresholds for pure tones (especially for higher frequency sounds); relatively greater increase in the speech perception threshold (including decreased ability to separate out speech from background noise); and disproportionately slower response times to auditory stimuli, related to age-related hearing loss, such as presbycusis[9] (see Carmichael 1999). These impairments are compounded by age-related physiological changes, such as the stiffening of the eardrum ('tympanic membrane'), calcification of middle ear bones and vascular changes in the cochlea and inner ear (Carmichael 1999), in addition to adverse environmental factors, such as over exposure to loud noise over long periods of time (Stuart-Hamilton, 2000).
- *Psychomotor:* in general, ageing brings about a slowing in performance and information processing. As a result, older adults generally take longer to realise the mistakes they are making (Morgan 2004). Changes in coordination, agility and movement also relate to physical changes in balance, elasticity and endurance, with a sharp decline in muscle strength for those over the age of 50, and significant reduction in hand grip strength for those over 75 (Huppert 2003).
- *Cognition*: decrements in efficiency mean getting older variably brings about a slowing of mental processes, including a decline in short-term memory, aspects of visual attention capacity (Fisk et al. 2004; Mynatt and Roger 2002) and slowing of perceptual speeds, with diminished accuracy recollecting and recognising contextual details of personal events and experiences (Marcoen et al. 2007). Comparative studies have demonstrated that, while both young and older adults can divide attention equally well when undertaking simple tasks (see Rogers 2000), cognitive factors like working

progressive ageing disorder in which a loss of flexibility in the eye's lens leads to a reduction in accommodation to focus clearly on near objects.

9 Common amongst the over 75s, *Presbycusis* is a gradual loss of hearing associated with physiological changes in the inner ear. In addition to diabetes, cardiovascular illness or other hereditary factors, it is typically caused by a lifetime exposure to environmental noise.

memory and reasoning decrease with task complexity, suggesting that older adults have more difficulty inhibiting irrelevant or distracting sources of information, causing greater interference in the selection of specific target information (Park 2000; Rogers 2000; Zacks et al. 2000). It is also well documented that there is a marked decline in 'fluid' abilities, namely those related to the manipulation and processing of information, such as spatial orientation, reasoning and abstraction. However, not all types of memory and mental resources diminish with age (Craik and Salthouse 2000). In particular, there is strong evidence to suggest that mental abilities based on *"bodies of information"* (Huppert 2003, p.41), such as 'crystallized intelligence' (i.e. abilities that depend on knowledge and experience) improve or remain impervious to change, even in very old age (Carmichael 1999). These include well-learned mental processes relating to procedural (i.e. prior knowledge of well-learnt activities and tasks) and semantic memory, the storage and recall of factual information, such as the retention of vocabulary skills (Marcoen et al. 2007).

In emphasising a progressive rather than a distinct phase of ageing, physiological decline is well known to manifest at different rates and degrees of severity relative to the individual (Mynatt and Rogers 2002). As a result, while many people will experience modest reductions in their abilities, others will become very frail and incapacitated. Within the older population, this inherent variability between *most* and *least* able (see **Figure 2**) has led to criticism over the notion of designing for the 'average' user, given that there are likely to be as many healthy and able bodied people whose expectations *"are at least as sophisticated as those who design for them"* (Rabbit and Carmichael 1994, p. 174). By comparison there will also be those who fall well below what can be considered as the 'average mark' (Carmichael 2002), as the incidence of severe disabilities, particularly multiple disabilities, becomes more prominent with age, producing greater restrictions in human performance. As a result, it must be acknowledged there is no simple or overriding solution to designing for age diversity. In other words, there is no 'magical check list' that can accommodate everyone (Rabbitt and Carmichael 1994).

Consequently, from a human factors perspective, such issues strengthen the argument for the need for dynamic and adaptable methodologies and evaluation techniques in working with older adults to fit within established and emerging paradigms of interaction.

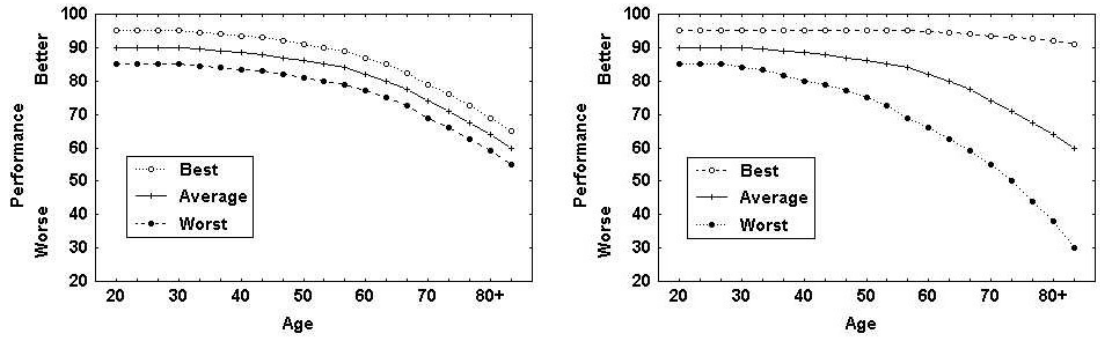

Figure 2: Illustrations of the decline in ageing functionality. (*Left*), the 'typical' assumption of age decline; (*right*), the more 'realistic' variations, i.e. some show virtually no change, while others experience relatively large amounts of degeneration (Carmichael 2002).

2.4 Designing for diversity

Advocates of design inclusion have long argued for a change in the perception of mainstream technologists and for designers to pay proper attention to the way products work, look, feel and respond to the people who use them (Newell 1995; Fisk et al. 2004; Zajicek 2005). A key challenge has been the adoption of design strategies and solutions to support a diverse range of users, built away from the stereotypical assumptions that older people are somehow 'special' to mainstream groups. This is considered necessary in order to raise awareness of the working practices of designers, who in affect, design for themselves and for those users who match their own characteristics and functional capabilities (Keates and Clarkson 2004; Newell et al. 2008).

As such, the inclusive design[10] movement has attempted to raise the profile of disabled and older people by encouraging the design of products that can be made available to the broadest range of people, thus enabling rather than excluding individuals (Keates and Clarkson 2004). This has been fuelled by responding changes in legislation (in Europe, the US and Japan) and

10 Also referred to as 'Design for All', 'Universal Design', 'Accessible Design' and 'Barrier-Free Design', they commonly support the design of products and services for the maximum number of people possible (The Center for Universal Design 2008).

advances in rehabilitation engineering and assistive technologies, many of which have focused on making products and services more accessible by extending the initial concept of the average user. Greater prominence is given to special needs groups. This is characterised by the design of assistive and adaptive technologies as alternative ways of accommodating and customising user interface features. These include models and software tools developed to establish design guidance in measuring different user capabilities across a range of demographic groups (e.g. see Keates et al. 2000; Porter et al. 2003).

As an extension to the inclusive design philosophy, Gregor and Newell (2001) propose the term *Designing for Dynamic Diversity* to understand the wide range of abilities within the population. Titled 'User *Sensitive* Inclusive Design" (as distinct to 'User *Centred* Design' which, they argue, focuses too narrowly on the requirements of 'average' users), it attempts to account for the functional variability within niche or specialised groups. The term *sensitive inclusive design* is therefore used to underline the importance of finding and recruiting representative users who have a more unique, or a more diverse set of characteristics, and is supportive of appropriate software adaptation.

Yet, despite the huge strides made by the inclusive design movement, there still remains an absence of innovation to accommodate and embrace 'human diversity'. Having previously introduced issues related to the development of domestic technologies in **Chapter 1**, testing and evaluating for design inclusion is still heavily concerned with developing methodologies to improve web-based interfaces. This includes automated checking tools like 'WAVE'[11], or standards for web site accessibility as, for example, recommended by the W3C[12]. Within both inclusive and product design there remains a strong promotion of more traditional HCI methods

11 http://wave.webaim.org/ (Accessed 21 October 2008).

12 The World Wide Web Consortium defines a number of international standards, including the Web Accessibility Initiative (WAI) developed to produce a series of web accessible guidelines. These include: 1) the *Web Content Accessibility Guidelines* (WCAG), to provide technical guidelines for the accessibility of web site content; 2) the Authoring Tool Accessibility Guidelines (ATAG), to support the creation and usage of web content authoring tools; and 3) the User Agent Accessibility Guidelines (UAAG), for developers of web browsing technology, to support and enhance accessibility of the content they give access too.

(i.e. user trials and questionnaires, check-lists and guidelines) emphasising a linear framework associated with the user-centred design process (Stanton and Young 1998; Cardoso et al. 2003). This often relates to a more regimented, engineering perspective of product development, in assuming a defined sequence of steps when working with end users, using conventional evaluation techniques. This, the author argues can demonstrate noticeable weaknesses in their validity and usefulness in designing for non-mainstream groups.

A particular example of this problem is the *think aloud protocol* (TAP), a common user-centred procedure for getting volunteers concurrently to verbalise what they are doing in a task, in order to reveal underlying mental processes in behaviour. Favoured in mainstream HCI (e.g. see Dix et al. 1993; Preece et al. 2002) and reported in over 500 papers in the Association for Computing Machinery library (ACM)[13], it has been established as a very useful means of clarifying user accuracy and identifying difficulties in interaction. By contrast, for non-mainstream groups, particularly those who use speech recognition systems, TAP is seen to interfere with both the speech application and spoken text (Dumas 2003). This issue is supported by a recent study by Chandrashekar et al. (2006) in which four blind users were asked to perform the think aloud protocol while reading text from a screen reader. The impracticalities of this technique were clearly demonstrated by the overarching demands of dividing attention between the two activities (that is completing the task while listening to the screen reader). Similarly, in working with older adults, TAP has also been identified to direct attention away from the activity at hand (Fisk et al. 2004), particularly in the context of using unfamiliar software applications (Dickinson et al. 2005).

In addition, while TAP has generated some debate over its effectiveness as a usability method (e.g. see Ramey et al. 2006), research within experimental psychology dating back to the 1970s has strongly argued the case that such verbalisation is severely flawed with regards to the representation of accurate introspective ‘data’. Referencing the work of Miller (see Nisbett and

13 As of September 2008.

Wilson 1977, p. 232) who states *"It is the result of thinking, not the process of thinking, that appears spontaneously in consciousness*", Nisbett and Wilson (1977) fundamentally argue it is our lack of cognitive awareness to comprehend complex aspects of our behaviour that illustrates the weakness of the verbal reporting approach. In other words, it is our human limitation in reasoning to determine consciously why we act the way we do, which brings into disrepute TAP's ability to probe related strategies in thinking. Wider questions that have recently been raised around improving the empirical validity of this method (Ramey et al. 2006), therefore appear irrelevant, given our lack of understanding towards higher order mental processes in evaluation and problem solving. As such, examples like TAP demonstrate the constraints of using established usability methods, which arguably in this case are no more beneficial to a more direct, but subjective, 'over the shoulder' observational approach.

In extending the understanding of the inclusive design process, designers like Bontoft and Pullin (2003) have, for example, argued the case for more creative prototyping methods to *emotionally engage* and facilitate user feedback, in what they describe as a need for more divergent ways of thinking about (preconceived) end users. However, crucially for older people, from a practical perspective, a lack of relevant literature has drawn concerns towards how best to involve those with technological inexperience (Eisma et al. 2003). This, in itself, is a reflection of the dominant number of computer studies that continue to be tested and evaluated with young, well-educated and 'techno-savvy' participants, accustomed to the techniques and technologies involved (Dickinson et al. 2007).

2.5 Interacting with older adults

Within ageing and HCI, a considerable amount of research has centred on the well-being of older adults through 'computer' and 'internet use'. Although not exhaustive, these studies have included:

- Personalised email applications (e.g. Hawthorn 2002; Dickinson et al. 2005);

- Web accessibility, including design guidelines for older adults for improving web-browsing facilities (e.g. Ellis and Kurniawan 2000; Mead et al. 2002; Kurniawan and Zaphiris 2005; Zaphiris et al. 2005);
- Attitudes and behaviour towards computers (Morris 1992; Czaja and Sharit 1998; Richardson et al. 2002);
- Training approaches designed to identify optimal learning strategies for older adults (Maythorn et al. 2004). This includes the use of computer classes and self-study sessions as a means to educate and evaluate the development of computational systems (Hawthorn 2005; Dewsbury and Dickinson 2006).

Consequently, given the focus towards desktop technologies, it could be assumed that there are adequate guidelines for working with older adults. On the contrary, as Eisma et al. (2003) suggests, there is little information available to inform designers how to 'actively' collaborate with older users in the user-centred design process. In computing, criticism has included the lack of differentiation towards older people as heterogeneous users (i.e. by not taking into account social-economic status, age, gender, etc. [Richardson et al. 2002]). However, less widely documented is the lack of design innovation presently stifling older adults contribution to new and exploratory, rather than 'predefined' and known technologies (Druin et al. 2007).

Of the limited number of studies that have challenged the stereotypical misconceptions and low expectations many designers have of older adults' use of technology, Eisma et al. (2003) describe the importance of working with the 'expertise' of older people, using hands-on reciprocal learning approaches. This has importance in making users aware of technological possibilities, as well as informing and educating computing professionals of the problems older people face when using new and unfamiliar systems. Described as *mutual inspiration*, it articulates a need to establish a common ground for all parties concerned. However, while at 'face value' these ideas seem very applicable, it is unclear and highly questionable how this

concept differs from more established participatory design[14] (PD) practices and associated *mutual learning* approaches which have long encouraged the empowerment of end users in the user-centred design process (e.g. see Schuler and Namioka 1993; Muller 2003).

More broadly, Eisma et al. (2003; 2004) provide little practical information on exploring the design of emerging, ill-defined 'information appliances' which may require unorthodox, multimodal styles of interaction more suitably developed for this age group. This appears to relate to wider HCI literature, indicating that practitioners and researchers have been far more successful identifying with and raising awareness of the key challenges and constraints of working with older adults, when compared with developing new methods or techniques that could better aid and inform the design process. To highlight, these challenges include:

- lack of confidence, producing apprehension and anxiety in using computer-based systems;
- lack of necessary knowledge in learning the conventions of software interfaces (Dickinson et al. 2005);
- difficulties in maintaining attention throughout in-depth requirements gathering activities (Barret and Kirk 2000);
- lack of well-developed design vocabulary, finding it more difficult to express design concepts (Hawthorn 2007);
- unfailing politeness, with a tendency to blame themselves for difficulties encountered (Hawthorn 2007).

In addition Eisma et al. (2003; 2004) have noted:

- more uncertainty of the possibilities of new technologies, requiring more 'concrete'

14 PD has long explored the necessity for new products and services to fit within the working practices of its inhabitants. Established in the 1970s in Scandinavia to give workers more control in the design of organisational systems in the workplace, today participatory design has emerged to include a wide number of techniques aimed towards supporting end user involvement in the development of a range of computer-based technologies.

examples to understand the use of a system;

- greater difficulties in understanding technical terms, concepts and metaphors of new technologies;
- more negative expectations in the amount of effort required to learn to use new applications;
- more reluctance to complain and criticise products and design concepts.

Overall, while some of these findings relate to perceived attitudes towards technology, others are associated more with a lack of skills and relevant experience in making appropriate judgements. Undoubtedly, while not true of all older adults, some of whom will be competent and confident using an array of 'digital' technologies, such findings help explain how the familiarity of electro-mechanical artefacts can be a strong inhibitor in older peoples understanding of new systems, and thus, their ability to envisage design possibilities (Carmichael 1999). In particular, the work of Docampo Rama (2001) and the phenomenon of *technology generations* gives evidence to the advantages younger people (i.e. those born after 1960) have in comprehending software style devices, compared to older adults who lack the same acquired knowledge and experience during their formative years. Exploring the usability of multi-layered interfaces, she argues, older generations are far less efficient in task completion, making significantly more errors than younger adults. Thus, by comparing task performance in relation to 'age' and 'generation' effects, Docampo Rama indicates that while generational differences are evident in using a new interface, they slowly diminish with experience. By contrast, the age effect remains a constant factor, regardless of the learnability of the interface.

Consequently, the impact of this 'generation gap' strongly brings into question how inexperienced older adults can sensibly articulate and comprehend ideas for new types of non-desktop (leisure-orientated) applications, given the countless possibilities available in software-

based technologies. This is noticeably different from desktop solutions that continue to place a strong onus on building upon established application models and the incremental modifications that occur in their functionality and usage to support the delineated tasks of a skilled workforce.

Hence, while user-based evaluations of specific technological components support the explicit motivation of work-based activities, conventionally centred on usability as a primary focus of investigation, they do not address the more 'grass root' challenges of how to gather the attention or rationales of users with limited experiences in the development of undefined design concepts. In particular, as reported in **Chapter 1**, given the appropriation of ICTs embedded in the dynamic and discursive practices of everyday life, the question of how to maximise older people's sustained involvement through a holistic process remains unidentified. Subsequently, in exploring the design space of evolving and contextualised environments like the home, the potential functions or appearances of new technology raises the extent to which inexperienced users can successfully articulate or comprehend new ideas.

Further, in having previously demonstrated issues in relation to working with older adults, not only does it strongly re-emphasise the discrepancies between developing for older and more mainstream groups, but it also illustrates the need for the careful implementation of methods to respond to the requirements of non-average users. This is what Hawthorn (2002 p. 38) describes as a need for design to explore the knowledge of the older user, rather than apply a so-called *"cookbook approach"*, commonly seen in many HCI studies. As such, beyond applications that centre on presenting users with more formalised ideas, there remains the uncertainty of how 'genuinely' to motivate and understand the mind sets of older adults.

Researchers like Dickinson et al. (2007) have identified practical issues in the recruitment for, and attendance at, studies for the evaluation of existing systems. This, however, is very different from approaches that have yet to establish an application's appearance, functionality and use context. Therefore, independent of the goals of the researcher/designer (which may strongly

differ from those of the target group), concern is raised about the amount of research that centres on capturing responses to pre-defined ideas based on the ‘assumptions’ (and preliminary consensus) of what is wanted or required by the end user. As such, there is a danger that designers will continue to undervalue or underestimate the abilities of the target group, given so many applications are built on the premise that technology is difficult to use for older people. To confront the challenges of how to design novel interfaces, greater user control in the establishment of new ideas is therefore required in order to understand better the desires, values and acquired knowledge attached to the individual. Central to the research question of how to design new applications, innovative research is clearly needed that will support the articulation of ideas from the viewpoint of the user, in order to more fully understand older people’s involvement throughout this process.

3. Digital interactive television (DITV)

3.1 Introduction

This final chapter of the literature review outlines the technological context of the thesis. Focusing on digital interactive television (DITV), it exemplifies a 'non-desktop' technology, in terms of its non-workplace and leisure orientated usage across the entire demographic population. However, it also represents a very disruptive technology, in breaking away from more familiar and conventional models of analogue television. In further addressing these issues, this chapter will first introduce the concept of DITV, describing the technical underpinning of the set-top box (STB). This is followed by a discussion of the relevant interaction issues associated with designing for the television environment. Finally, the chapter concludes by focusing on some of the key limitations of the medium for older adults, including the poor design of on-screen displays and remote controls, and the provision and access of associated services.

3.2 The move towards digital

Television is changing. According to Jensen (2005), the shift from analogue to digital TV enriches the viewing experience through an array of entertainment and information services. However, while many people increasingly recognise (at least loosely) the term 'interactive television', a lack of an agreed definition remains. Amongst the different philosophies used to describe 'interactivity', lies the problem in what it means to interact with television, given that it is considered neither a static medium, technology, nor service (Jensen 2006).

In narrowing down a description, one possibility is that the different forms of the television medium can be based on the types of consumption available. This can be separated between the 'traditional' one-way nature of switching between different modes of viewing, from the point of concentrating intensely, to relaxing in front of the 'set', to additional 'lean-forward' functionalities now provided through 'digital'. Alternatives can also be experienced in relation

to the technology or platform delivery (e.g. mobile, Internet and IP TV.), including associated services and applications which vary in their levels of interactivity and audience engagement. These include:

- **Enhanced:** Electronic Programme Guide (EPG), digital Teletext.
- **Interactive:** Shopping, banking, gambling, advertising, gaming, e-learning.
- **Public:** Health, local government services.
- **Personalised**: Video-On-Demand (and Near Video-On-Demand), Personal Video Recorder (PVR).
- **Communication:** Email, SMS, TV chatting services.

Amongst these emerging changes, cross-disciplinary areas of media and communication studies have long explored the role of television amongst older people. For example, this has included how television usage can maintain well-being by providing a sense of social companionship (e.g. see Rubin and Rubin 1982). Demographically, older people are known to represent a high percentage of television viewers in the UK, particularly amongst daytime audiences. For those over 55 years, average viewing times are 34 hours per week (BBC 2007). This significant percentage of television usage is reflected in the 37% of people aged 65 and over who *"spend 'all or nearly all' of their leisure time at home, compared to 17% of all UK adults"* (Ofcom 2007b, p. 8).

However, despite television's social importance within society at large, the move towards digital television has meant that its ownership is considerably lower for vulnerable groups of older people and those on low incomes, who are facing expense and uncertainty over what to buy, and are less likely to have Internet access at home (Ofcom 2007a). Presently, these issues are further hindered by a lack of attention towards the types of television services that could most benefit many older users, including the services' accompanying forms of interaction. Consequently, it remains highly questionable how DITV can better accommodate this wide and important

segment of the viewing population, given the present danger of these users being further disenfranchised.

3.3 Interactivity, delivery and technology

Lower level digital terrestrial television (DTT) is typically transmitted through the existing analogue infrastructure using ground-based transmitters and is currently (in the UK at least) the most popular option for subscription-free reception[15] (Ofcom 2008). However, this platform is relatively limited in the extent to which it can support interactivity, as it does not include an inherent return path[16]. Limited interactive services can be provided without a return path, but this requires that the interactive functionality and related content be downloaded to the local reception equipment. Thus, interactivity is generally limited by the storage capacity and processing power available locally in the domestic set-top box (STB) equipment.

By contrast, 'full' interactivity (i.e. interaction with the 'source' of the service being provided) requires additional arrangements, usually involving higher bandwidth efficiency via a PC modem or digital subscriber line (DSL). In establishing a return path channel between the audience and service provider, viewers' commands and responses can be delivered, with or independent to the broadcast service (Peng 2002). This option is important for services requiring the audience to send back information to the service provider, for example, to complete a third party transaction for gaming, betting, and shopping channels, each of which requires authentic identification and adequate broadband capacity.

3.3.1 Set-top box architecture

Designed to optimise the presentation of pushed content (Schwalb 2004), a set-top box can be either a customised computer system embedded into an integrated television set, or a separate device. The main functionality includes:

15 Other subscription-free possibilities include 'Freesat', available via digital satellite.

16 A return path or back channel allows for the two-way interaction of information via a network operator to end user (or vice versa).

- internally processing the broadcasting signal;
- providing conditional access verification;
- separating and formatting the audio and video streams;
- allowing for the interaction of available content.

Typically, STBs can be distinguished between ‘thick’ and ‘thin’ clients. Low in storage and processing capacity, thin clients typically produce enough basic functionality to handle a standard electronic programme guide and ‘enhanced’ services. Thick clients, despite being less widely deployed, are far more powerful and robust receivers, able to support a wider variety of multimedia and standalone operations. As such, it must be recognised that while STBs share a number of common hardware features, technical specifications vary widely. To highlight these differences, STBs systems can be separated into the following categorises:

- **Enhanced broadcast STBs**: a thin client, without a return path facility they are limited to the rendering and display of information services from the audio-video broadcast. Such receivers are restricted to supporting local interaction.
- **Interactive STBs**: access to a return path means these systems are capable of providing additional email/instant messaging and other two-way services via ‘wall garden’ access (i.e. access to interactive services under a controlled environment [Gawlinski 2003]).
- **Advanced STBs**: offering more then ten times the processing speed of first generation systems (O’Driscoll 1999), they include media centres and high-end game consoles (e.g. X-Box 360) deployable over a high speed DSL or co-axial cable, able to deliver voice and videophony, as well as support scheduled and time-shift recording via a local PVR hard drive. Advanced and interactive STBs can be considered as thick clients.

Compared to a PC, these specifications typically run on very low CPU and memory capacity. Next generation consumer electronics, such as Intel’s CE 2110 Media Processor aim to offer far more power in the deployment of IP-based applications (Intel 2008). Yet, despite this, many

current computational processors on the market (regardless of the platform) are limited in their ability to run multiple applications and undertake multitasking activities, reflected in the 70% of CPU time devoted to running these applications (Evain 1998). Given this limitation it is recommended that only one application should be fully active at any given time (The MHP Guide 2006).

The low specification of many boxes is further complicated by the software compatibility of 'older' STBs to be upgraded via the broadcasting stream, or relevant return path. This problem is also complicated by the legacy issue, ensuring that broadcasting services must be deliverable across a wide spectrum of systems, dating back to first generation receivers (Springett and Griffiths 2007), which may be over 10-15 years old. As a result, there is an increasing gap in system performance between newer, higher-end, and low processing units that are no longer in manufacture but are still in domestic use.

To highlight this issue, the Home Multimedia Platform[17] (MHP) has defined three profiles (see **Table 2**) for the minimum processing and memory requirements for:

- **enhanced broadcast** and access to local broadcast services without a return path;
- **interactive broadcast** for interactive applications supported via a return path facility;
- **Internet access** and provision of Internet services, including web browser applications.

17 MHP is a European open middleware standard designed for the development of digital video broadcasting. It has also been extended using the GEM (Globally Executable MHP) specification to allow other regional bodies, such as the Advanced Common Application Platform (ACAP) in North America, or Association of Radio Industries and Business (ARIB) in Japan to incorporate a lighter version of this standard.

Platform	Processor	RAM	FLASH/ROM
Basic STB	30 MHz+	1-2 MB	1-2 MB
MHP **Enhanced broadcast** profile	8-130 MHz+	8-16 MB	4 MB
MHP **Interactive broadcast** profile	80-130 MHz+	8-16 MB	8 MB
MHP **Internet access** profile	150-200 MHz+	16-32 MB	16 MB

Table 2: Examples of hardware profiles for MHP (Hinze-Hoare 2004)

3.3.2 The hardware architecture

In terms of understanding the STB architecture, a more detailed analysis reveals a number of key hardware components (see **Figure 3**). These include:

- **Tuner(s), demodulator and demultiplexer**: the tuner is responsible for isolating the broadcasting stream, that transports channel information from a range of frequencies sent out to the receiver. This is supported by the demodulator, an electronic circuit which separates the audio and video signals from the carrying frequency and converts it into a digital bit-stream, and the demultiplexer, which synchronises the transport stream, identifies the different elements and separates the audio and video according to the service selected by the viewer (Peng 2002; Gawlinski 2003).
- **Decoders**: these consist of video, audio and data decoders for decompressing the MPEG-2[18] digital stream, formatting resolutions and aspect ratios, decompressing and translating the audio content, and appropriately encoding channel information (Zhang 2003).
- **Microprocessor:** functions of the CPU include managing operations within internal components, in addition to the monitoring of hardware interruptions. Memory consists of Random Access Memory (RAM), Read Only Memory (ROM) and Flash memory (Zhang 2003). RAM memory is used for video and audio buffering, while ROM is responsible for storing libraries, the virtual machine, the operating system and the file

18 This standard defines the basic concepts for the provision of digital audio-video services in DITV, defining both the signal compression, packetisation and multiplexing of digital content across the broadcast stream.

system (Evain 1998). Alternatively, non-volatile Flash memory allows for the storage of some resident data and the updating of additional software components in the STB (O'Driscoll, 1999).

- **External interfaces**: these include smart card readers typically used to purchase pay-per view services, one or more SCART connection, a parallel port (IEEE 1284) and universal serial bus (USB) for external hard drive interoperability and 'plug and play' facilities.

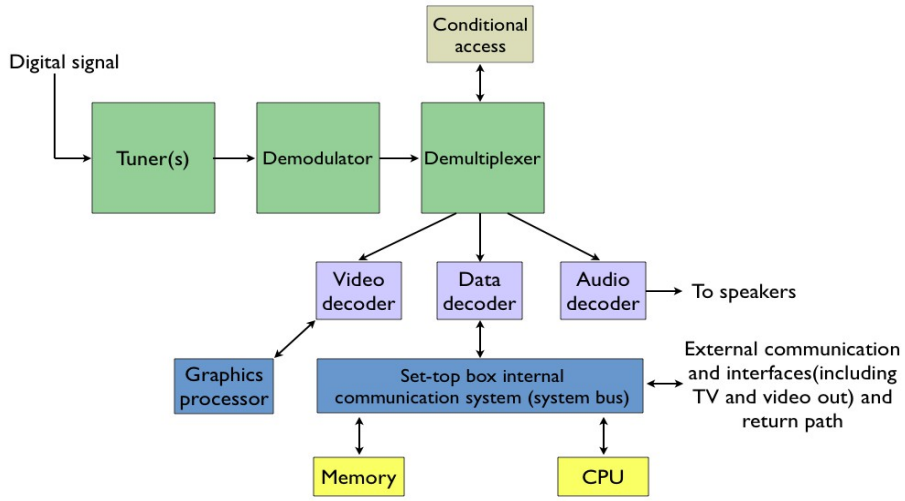

Figure 3: Typical hardware infrastructure of a set-top box (Gawlinski 2003)

3.3.3 The software environment

Software processed by the CPU manages the hardware components in the unit, as well as the presentation of information and interactivity (Gawlinski 2003). These software components include:

- **Conditional access (CA)**: used to control a subscriber's access to pay-per-view services, requiring valid authorisation. Restriction to a particular service is accomplished by applying various cryptography methods via a subscriber management system and security module.
- **Real-time operating system (RTOS)**: designed to exist within the ROM or Flash memory, core elements include the multitasking kernel responsible for managing

memory resources and data transmission, and a loader enabling the upgrade of OS patches (O'Driscoll 1999). RTOS also contains a set of Application Programming Interfaces[19] (APIs) required for the development of higher-level applications. Lower levels of the operating system include the system services layer, consisting of configuration details for the graphic display, known as the device manager, as well as a number of interface drivers.

- **Middleware**: this can be thought of as the abstract interaction layer between the application and operating system and is responsible for managing real-time events, preventing internal hardware damage, and monitoring behavioural changes in the data (Gawlinski 2003; Morris 2006). In addition, it also reduces the complexity of software development by providing a set of common APIs for software developers using appropriate declarative or procedural[20] environments (Morris 2006). Middleware can be divided between open and proprietary systems. Open middleware includes *MHP*, a subset of Java, *Java TV* developed by Sun Microsystems and *MHEG-5*, typically deployed on a number of terrestrial receivers in the UK. Proprietary middleware includes *Open TV*, *Power TV*, *Media Highway*, *Osmosys*, *Microsoft TV* and *NDS core*, which as an alternative to 'open standards' tends to be designed to be licensed to a specific STB manufacturer (Morris 2005).

3.4 Driving factors

From a *commercial perspective*, the move toward digital TV offers enormous opportunities to increase subscription numbers and generate other highly lucrative revenue streams. In particular, the break down of analogue television and the proliferation of new digital channels has meant new marketing strategies are required to reflect the changes in centralised broadcasting (including audience fragmentation), both to reinforce branding messages, and to encourage

19 An API is a set of procedures, functions or classes providing the necessary 'building blocks' for an application's development.

20 Declarative environments are used to describe 'what', rather than 'how' the computational logic of a program should be performed. By contrast, procedural environments use lower level functions and methods, following a more explicit set of procedures.

impulsive buying. There has also been a growing number of cross media advertising campaigns launched on both TV and Internet platforms, as a more effective means of generating revenue for advertisers. This can involve 'jumping to' a micro site (a mini-website) or Dedicated Advertiser Location (DAL) that contains product information, interactive games, or other related merchandise.

Similar to e-commerce undertaken on the Internet, t-commerce is primarily designed for the purchasing of goods in the TV environment, and includes the development of lifestyle, home shopping, travel, banking, gambling, pay-per-view subscriptions, and other TV-based product sales. Present estimates indicate that in relation to the Internet, on-line shopping through DITV and mobile devices will equate to about £40.5 billion by 2010 (Royal Mail, undated). However, despite the huge revenue earners, it is important to recognise that DITV is likely (in the foreseeable future at least) to remain a highly fragmented market.

The STB sector can be separated into horizontal and vertical markets, varying between receivers mass deployed by network operators, to those sold directly through the retail industry. Presently, on a vertical market, options for more advanced digital receivers are stifled by the huge overheads required by network operators to deploy many thousands of STBs nationwide (Morris and Smith-Chaigneau 2005). Alternatively, the possibility for an open mandate standard is unpopular by commercial factions (e.g. broadcasters and manufacturers), foreseeing regulatory intervention as impeding economic development, rather than sustaining innovation (The Digital Interoperability Forum 2003). In this case, true interoperability is seen to come from industrial collaboration and free enterprise, despite growing unease in Europe for member states to publicly regulate standards and create an open API to increase the level of transparency in the deployment of digital applications (Commission of the European Communities 2004).

From a *public perspective,* Government's like the UK have taken an interest in the revenue available from the increased bandwidth that the analogue switch-off will provide. For this and

other reasons (such as the high national penetration of television usage), DITV is favoured for delivering various 'e-Government' services, particularly for people who are reluctant or unable to use computer systems (with the emphasis on marginalised groups such as older people and those with learning difficulties) (Office of the e-Envoy 2003). A number of initiatives have been launched, including NHS TV, to provide information on local services (GPs, dentists, and pharmacies), advice on healthy living, and treatment on common health problems (NHS Direct 2004). These have also included various pilot projects run with local authorities, offering e-services on DITV to improve community development (e.g. DigiTV Project 2004).

However, while the provision of these services on-line may be cost effective, they will inevitably reduce the availability of face-to-face contact between providers and recipients. This is of particular concern given the significant numbers of older people who already depend on intermediaries to cope with complex transactions such as claiming income support, and who are likely to face the greatest barriers in taking up and interacting with DITV generally (Irving et al. 2003).

3.5 Television-mediated interaction

Typically, the 'leisure' context of DITV emphasises measures relating to users' subjective experiences, such as perceived ease of use and acceptability. In particular, the role of acceptability is essential, given that DITV is aimed at replacing an extant and highly familiar technology, and is likely to cause some degree of disruption. As discussed in **Chapter 1**, it is critical that greater emphasis be placed upon how technology takes into account the social character of the domestic environment, and how the design of DITV interfaces ensures that as well as 'fitting' people *per se*, the proposed technology will also 'fit' into their everyday lives.

The impact of interactive functionality in *television-mediated interaction* represents the most fundamental changes in home viewing, as the addition of 'interactivity' impacts upon (and to some extent risks eroding) the familiarity and trusted status of the medium. In particular, the

'push' to get viewers to treat television viewing increasingly as a lean forward activity, mainly in an attempt to increase their level of engagement, continues to make TV viewing more like computer usage. Compared to the PC, digital television is technically, operationally and socially distinct. For example:

- commercial assistive technologies, compatible with DITV equipment, do not exist in a PC environment;
- traditional CRT television screens generally have a lower resolution, as well as different scanning rates, and colour safe palettes compared to computer LCD monitors (see **Section 3.5.1**);
- viewing distances are substantially greater and more laterally variable when watching television then when operating a PC, requiring viewers to divide their cognitive attention between watching and interacting with broadcast programmes and services.
- watching television can be an individual or group activity, and can variously be the focus of concentrated attention, a facilitator for discussion or 'background noise' while undertaking other household activities;
- the television audience is more diverse and includes many people without any computing experience and/or interest (including those who, for whatever reason, would find a PC difficult to use).

3.5.1 Design and implementation

A more detailed analysis of designing for DITV reveals that there are a number of software implementation issues that need to be considered. Not only in terms of latency, bandwidth and memory issues, but also fundamental differences in the graphics API for television, which can constitute different appearances depending on the platform environment.

For example, according to Cesar et al. (2006) STB systems can consist of two underlying architectures, window-based or scene-based user interfaces. The former divides the screen into

different regions or windows, while the latter considers the screen as a scene composed of precisely positioned multimedia objects (Cesar et al. 2006). Typically, the DITV display consists of a background plane (limited to a single colour or static image), video and graphics planes, with in some cases a separate cursor plane (Schwalb 2004), see **Figure 4**. All layers should be configured separately. However, in practice they are commonly shared to free up hardware components (Morris and Smith-Chaigneau 2005). For middleware MHP specifications, the minimum device resolution for background, video and graphics layers is set at 720 x 576 pixels (1024 x 576 for 16:9).

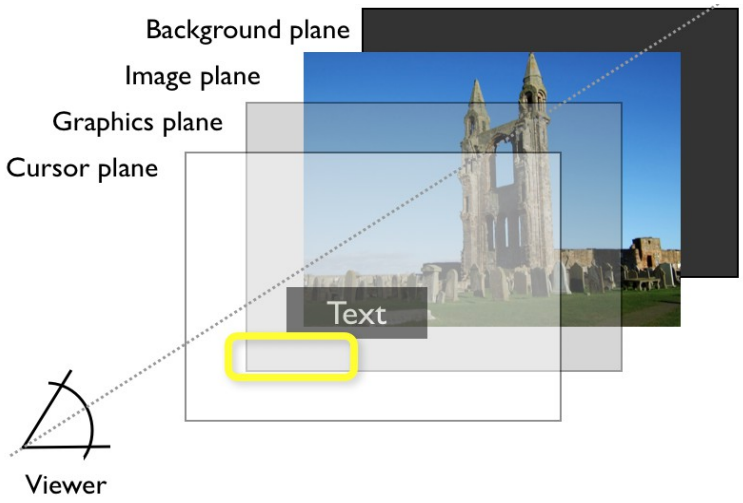

Figure 4: Display planes

A more detailed analysis of middleware and television environments indicates that a number of technical issues need to be addressed in relation to designing for the STB platform. They include:

- *Screen resolution:* differences in pixel composition between TV and computer user interfaces is a major reason for varying resolutions. Decoders in set-top boxes usually have a fairly limited configuration in displaying video to 'full' or 'quarter' screen (Morris 2006).
- *Aspect ratio*: display devices need to be able to resize the aspect ratio depending on the TV format (e.g. 4:3, 16:9). However, because televisions with standard aspect ratios use a fixed number of pixels per horizontal line, this typically will lead to a distortion or

stretching of an image's dimensions.

- *Colour configuration*: depending on the manufacturer, STBs are susceptible to colour mismatch as part of the colour conversion process (The MHP Guide 2006). For televisions (particularly CRT displays), known luminance and chroma problems include dot crawl (the continuous movement of dots around the sharp contrast of an image) and moiré patterns (interference caused from two sets of similar grid patterns). Furthermore, a limited colour palette (as low as 256 colours) or gamut range[21] can also cause colour complications when the display is fed a signal outside its normal range, resulting in the 'blooming' and 'bleeding' of colour (see **Figure 5**). As televisions have higher gamma values (compared to a PC display), this results in a higher contrast and saturation of colours, such as reds, yellows and oranges, while pure whites and blacks tend to cause an imbalanced picture. To overcome such visual disturbances, a limited RGB (Red, Green and Blue) colour range of between 16 and 235 is recommended (Galore and Kelsey 2002).

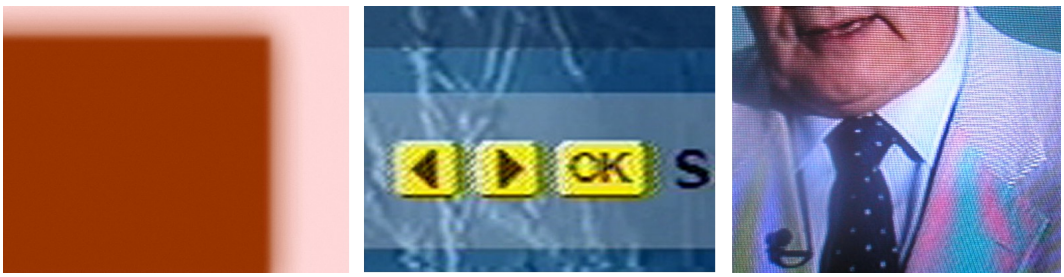

Figure 5: Examples of television distortion effects. (*Left*), colour bleeding; (*middle*), dot crawl[22] and (*right*), moire patterns.

- *Cursor control:* many STBs do not support free cursor movement. Instead, user input is reliant on the support of remote control key codes and the use of key press functions.
- *The window manager:* standard STBs avoid the use of a window manager, meaning that applications cannot be moved or rescaled as in a desktop environment.
- *3D graphics:* despite the availability of 3D APIs such as Java 3D or Direct3D, external

21 The complete subset of colours used within the STB system.
22 http://en.wikipedia.org/wiki/Image:Crawl.jpg (Accessed 15 August 2008).

native libraries are not specified by open middleware standards, such as by MHP or Java TV (Ugarte et al. 2007). With interactive STBs, the rendering of 3D graphics is particularly difficult to achieve, given that many systems lack sufficient storage and computational power, and a built-in graphics card (Zhang 2003). Open source APIs such as OpenGL are also not suited to distributing applications via a broadcast stream, while studies deployed on a 3D avatar application running on a 200 MHz CPU, found rendering frame rates to be far below minimum requirements for successful 'real-time' animation (Ugarte et al. 2007). Such limitations have been found to have a particular importance on later development work as reported in **Chapter 8**.

- *Text display*: the low resolution and contrast of CRTs make text harder to read, while larger font sizes limit the amount of text that can be displayed at any given time. Differences in display screen resolution affect the way textual characters are composed, including noticeable differences in colour definition through the use of active light from TV monitors (Carmichael 1999). Distortion of text on conventional systems is largely due to the fact that traditional interlacing techniques are less than ideal for the display of alphanumeric data, as each letter formed from the interlace scanning of two fields making up the image is more prone to 'interline flicker' (Silver et al. 1998). While commercial guidelines favour the use of larger sans-serif over serif and ornate fonts (BBC 2006), research into the effects of TV screen legibility is limited (Carmichael 1999). This is significant, particularly as the increased susceptibility of many older people to lower levels of contrast sensitivity means that text distortion can undoubtedly cause problems in visual interpretation of screen-based information (Gill and Perera 2003).

Beyond the technical issues described above, few best practice guidelines are publicly available from broadcasters and middleware vendors to support the development of interactive content for television displays, with none explicitly addressing the issues of designing for older people (e.g. BBC 2006). On the other hand, of the few research studies that have investigated the design of

DITV applications for ageing adults, beyond evaluating the usability of existing services (e.g. Obrist et al. 2007) only one notable study has involved novel interaction approaches for this user group (Carmichael et al. 2003). In this instance, exploring the development of a TV-based avatar system, the researchers reported that older volunteers generally experienced more interaction difficulties than their younger visually impaired counterparts. In particular, they found that older participants had disproportionately more difficulties understanding and responding to implicit spoken prompts.

3.6 Failure of early interactive systems

Given the current constraints when designing for the STB environment, this research draws upon early ventures into interactive television and the subsequent failure of many stakeholders to heed these early mistakes. From the early 1970s, broadcasters understood television to be a powerful tool in data communication (Swedlow 2000). In the UK this began with the development of on-screen text for hearing impaired users, then later the production of decoder units that could receive low-cost information services (e.g. Teletext), which rapidly became integrated into TV sets.

In the United States, equivalent first generation systems included Viewtron (see **Figure 6**), which adapted a more graphically orientated version of Teletext pages called Videotex. Yet, despite being marketed as an immensely desirable, futuristic and user-friendly technology, it failed less than three years after becoming commercially available, due in part to a lack of consumer demand and high subscription costs.

Within this lack of consumer demand lies evidence for the impact of early mistakes in user-centred design. In Viewtron's case, this included a lack of human factors research. The research made unsubstantiated assumptions about aspects of technology use and acceptability, including the design of complex multi-layered hierarchical menu structures and a difficult to use remote control keypad. Furthermore, preliminary market trials were limited to relatively small sample

sizes, in what appeared to consist mainly of 'early adopters'[23]. Despite internal pressure to push for positive ratings among participants, *"only 4 out of 10 customers…continued to subscribe after six months"* (Fidler 1997 p. 154), which contributed to further financial instability, and ultimately failure of the service.

Figure 6: Screen shots of (*left*) the Viewtron user interface[24] and (*right*) the Qube remote control[25].

Concurrent with the development of the Viewtron, similar interactive systems were developed such as Qube**,** launched by Warner Communications, and Amex Cable. Unlike any of its contemporaries, Qube offered a number of basic two-way interaction services which allowed cable subscribers to select pay-per-view movies and access interactive content through education or talk show programmes. Yet, despite early commercial optimism, the system failed to generate enough revenue, and was finally abandoned by the mid 1980s. Employee reports suggested that only about 20% of subscribers were using the interactive services available. Low participation was linked specifically to the lack of true interactivity available through services that often restricted user input to "simple yes/no or numerical responses" (Fidler 1997, p. 161).

23 Relating to those people that are keen to embrace the adoption of new technology, this number is generally considered a much lower percentage compared to 'middle to late adopters', who continue to represent a more widespread proportion of the population. This is in sharp contrast to the exclusionary term of 'laggers' or 'technophobes', who are generally perceived as being reluctant adopters of new technology, of which stereotypically many older people will fit within.

24 http://iml.jou.ufl.edu/CARLSON/history/viewtron.htm (Accessed 17 September 2008).

25 http://en.wikipedia.org/wiki/QubeTV (Accessed 17 September 2008).

As predecessors of more advanced interactive television technologies throughout the late eighties and early nineties, Viewtron and Qube are good examples of interactive systems that were part of a *technology push* for innovation and development, yet had seemingly limited knowledge of audience behaviour in using such applications. The technologies illustrate the necessity to invest sufficient time and resources on user needs and capabilities, particularly in researching the relationship between people and such technologies within the domestic, social context.

3.7 The status quo: present 'accessibility' constraints

At the time of writing, many countries worldwide are experiencing a 'digital switchover' from analogue to digital television. In the UK alone, given the imperatives of legislation such as the Disability Discrimination Act (1995) and The Communications Act (2003), the emergence of DITV should be overtly raising and addressing the issues of 'digital inclusion' to ensure that the broadest range of people can obtain the maximum benefit that this technological infrastructure can provide. The extra bandwidth available allows for a more efficient and targeted delivery of accessibility features along with each programme, offering significant potential for enhancing access to television content for people with sensory, motor and cognitive impairments.

Traditional accessibility features are those that would be commonly recognised by broadcasters and regulators. Indeed, some of these features will be familiar to many viewers, given their benefit to people beyond those with impairments whom they directly support. These features include:

- *Subtitles/Captions*[26]: the provision of on-screen text alternatives for spoken and other important non-spoken sound information, provided for people who are deaf or hard of hearing, or otherwise have difficulty hearing the broadcast sound.
- *Audio description*: additional spoken audio, delivered at appropriate times during quiet

26 In the UK, subtitles refer both to on-screen text that is a translation of (foreign) spoken content, and to text representing spoken and non-spoken audio content for deaf and hard of hearing viewers. The latter is known as 'captions' virtually everywhere else in the world.

periods of the programme's soundtrack, delivering essential descriptive information to aid understanding for people who have difficulty seeing, or cannot see the screen.

- *Signing*: the provision of a real-time signed translation of the spoken content. This may be an accessibility solution for those whose first language is not that of the broadcast content, but is more likely to be useful for people who are deaf.

In addition, less well known accessibility features have also been promoted, although there is no current obligation by the industry to comply. These include:

- *Audio-enabled EPG*: to support people unable to see the screen due to a visual impairment to effectively and independently choose their preferred viewing schedule (including the identification of 'accessible' programmes) and navigate the information space, the on-screen EPG must be presented in audio format, be understandable, and navigable without vision (Carmichael 2002).
- *Personalised display*: this includes allowing viewers to customise the appearance of on-screen text; for example, changing size, colour or font; avoiding a reliance of colour to distinguish either remote control buttons or on-screen information. Recommendations include the optimisation of graphical output (e.g. colour contrast, screen spacing, and typeface) for people with low vision (Gill and Perera 2003; Rice 2003).
- *Easy-to-operate remote control*: for many people with reduced cognitive processing ability, limited vision and/or manual dexterity, the remote control is a significant barrier, not simply as the way in which DITV content and services must be accessed, but also as it may be the only means by which other DITV accessibility features can be enabled.

Within DITV, the 'modes' by which the content of programmes is presented, such as subtitles, signing and audio description allows viewers to access elements of a programme they would otherwise miss. Yet, given the markedly increased complexity of both the information and communication space to which DITV enables access, and the nature of even basic tasks related

to interacting with that space, including finding and activating accessibility features, the adverse impact on usability can be a major issue. For example, unlike analogue TV, where subtitles are effectively one 'page' of Teletext, utilising DITV subtitles may involve significant navigation, which can introduce further difficulties. A variety of research has indicated that this sort of 'unlearning/relearning' of a familiar (but often implicit) mental model is difficult for older people (e.g. Carmichael 1999). Furthermore, while some progress has been made towards a voluntary standard for assigning a dedicated button on the remote control for subtitles, including research and development into a form of graphical representation, called *emotive captions*, designed specifically to support hearing impaired viewers (Lee et al. 2007), there is no immediate prospect of the same in regards to audio description. Accessing an audio described programme means the viewer needs to find a programme they want to watch and ascertain whether it is audio described. Not only is this a significant obstacle for people with low vision, but one that is further exacerbated by the high percentage of the population forecast to be excluded from the poor design of STB equipment:

> *Based on today's equipment, an additional two million people (4.4% of those able to access analogue television) could be excluded from simply viewing the new digital services using digital terrestrial television set top boxes at switchover. A further 700,000 people (1.6% of those able to access analogue television) would be excluded from using advanced features such as digital text and interactive services (DTI/The Generics Group 2003, p. 2)*

The authors of the 'exclusion analysis' upon which this summary is based (Clarkson and Keates 2003, p. 23) indicate the figures to be 'significantly conservative' due to the sample size and self-report measures involved. In addition to sample size *per se*, the sample used in this analysis is limited in the extent to which it represents the wider population, as it only included those living in private homes. This excludes many older people who are frailer and/or less independent. Given this, it may be that these 'exclusion' figures are closer to the 20% of the population who have difficulty *"performing one or more basic activity"* and the additional 7.5% of the population who are *"unable to walk, lift, hear, or read alone without help"* (Gregor et al.

2005, p. 296). Further to this, but even less quantifiable, is that the exclusion analysis appears to be based on 'absolute' exclusion. That is, it only considered those who cannot carry out the necessary tasks involved, not those who would experience enough difficulty such that they are effectively excluded. As discussed in **Chapter 2**, this is particularly salient in regard to older people who can be affected by multiple minor impairments. While each impairment in isolation may be below the threshold of 'exclusion', there is a variety of evidence to indicate that, for many older people, *"multiple minor (and sometimes major) impairments can interact... to produce a handicap that is greater than the effects of the individual impairments"* (Gregor et al. 2005, p. 305). In summary, this suggests that an unacceptably large minority of the older UK population (and beyond) will be effectively excluded from DITV.

A number of noticeable barriers have therefore been identified. These include:

3.7.1 The remote control

A range of fundamental usability problems relate to the conventional remote control handset. Perhaps the most clearly identified of these involve the problem of too many buttons, placed too closely together, with little meaningful grouping and often inadequate labelling. Whilst for many people this is little more than 'fiddly', for many older people it can cause significant difficulties (Parsons et al. 1994). These problems can be further exacerbated by, on the one hand, the similarity of TV and STB (and DVD etc.) handsets causing confusion over which controls what, and on the other, the lack of consistency between handsets regarding the specific layout and mode of multifunctional buttons (Springett and Griffiths 2007). These issues conspire together to make it very unlikely that anyone becomes familiar enough with the button layout to avoid continually having to pay attention to the handset in order to find a particular button (Carmichael 1999). This adds to the basic ergonomic problems of remote controls by presenting the viewer with effectively two related but spatially separate interfaces to deal with. This can be problematic for many people, but particularly for older people (e.g. Craik and Salthouse 2000) or those with visual or dexterity limitations.

3.7.2 Dual interface

The problems caused by this 'two interface' situation are most apparent in the dynamic operations involved in an on-going interaction (Carmichael 1999). To illustrate, a viewer will look at the on-screen display which will provide information either directly or indirectly about the available operations, and which button(s) to press. As previously discussed in **Section 2.3**, age-related changes to vision and cognition can combine to make this fairly straightforward procedure significantly more effortful, and potentially error prone (Carmichael 1999). Changes to working memory increase the possibility of the appropriate button's identity being forgotten before it is actually located, meaning the viewer must start again by returning to the on-screen display. The difficulties of switching visual attention between these two interface elements are further exacerbated for older people who require different corrective lenses for the different viewing distances involved (Carmichael 1999). The necessity of changing spectacles in this way adds to the time taken to switch from screen to remote control, and further increases the probability of forgetting. Similarly, screen fixation problems have been found to be particularly problematic for people with low vision, who are constrained to close screen proximity due to severe reductions in field of vision (Rice and Fels 2004).

3.7.3 Navigation

Beyond the sheer quantity of buttons, the need to attend (often closely) to the handset is also increased by the wide range of ways that on-screen objects and other interaction operations are mapped onto handset controls. For example, the mapping may be simple and direct, such as activating numbered list items with the appropriate numerical button/s. Conversely, 'navigational' functions such as 'back (one step)' or 'back (to TV)' seem inherently difficult to map unambiguously onto existing buttons (Lessiter et al. 2004). This highlights another fundamental usability problem regarding the remote control: the number of available functions far outstrips the number of available buttons, which means that multiple mapping is inevitable. Additionally, some functions are only available some of the time, meaning that the system works differently in different modes. Unless the viewer knows which particular mode the

system is currently in, and understands the implications of this, then a successful and satisfying interaction is unlikely. This type of 'mode problem' is known to cause difficulty for naive users of interactive systems (see Carmichael 1999; Daly-Jones 2002).

Overall, many of these problems could be addressed by taking greater account of their impact on the people who are expected to use the system. In simple terms this relates to increasingly rigorous and comprehensive user evaluation during development. At the same time, as will be demonstrated in **Chapters 7-8** of the thesis, such poor interaction styles mean there is huge scope for new interactive models that have yet to be investigated.

3.8 Literature summary

To summarise the literature review of the thesis, three interrelated themes have been identified. They include:

- **The environment**: designing for the domestic legacy is a highly complex and dynamic sphere, in which the appropriation and consumption of digital media varies significantly from household to household. As such, differences in experience and behaviour call for a shift away from computer metaphors and principles primarily associated with the productivity and efficiency of work.
- **The target group**: within this environment, older people remain at the fringes of product development. In HCI, user-centred methods continue to be constrained by the notion of designing for the 'average user' (and group homogeneity), failing to develop strategies that capitalise on the ambitions, (mis)understandings and motivations of older people towards technology *per se*.
- **The technology**: transforming DITV requires a shift in thinking to consider its social usage, and to compensate for the technical limitations and poor interaction that will continue to segregate rather than accommodate many older audiences.

Consequently, the types of research methods applied to engage, embrace and innovate the design of domestic technologies for older people remain a key issue. As a result, this thesis presents a somewhat unorthodox approach to investigating early stages of the user-centred design process. It will focus on requirements gathering and early evaluation phases, to establish application ideas and explore issues related to the interaction of such applications. To begin answering these questions, the first stage identifies the challenges and constraints of generating ideas with older adults using traditional focus group and individual interview techniques.

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4. Initial requirements gathering with older adults

4.1 Introduction

Focus groups have had along association with marketing research, typically used to test and assess responses in the adoption of new products (Bloor et al. 2001). This often involves using a small set of participants, typically between 6-12 users (although this can vary) with relevant interests in the brand or product concept. Cheap and relatively easy to assemble, they are considered a good way of collecting data on the means and norms that underline the group (Morgan 1997), particularly in testing *"how well messages resonate with specific target groups"* (Kroll et al. 2007, p. 690). However, while it is widely documented that a skilled and experienced moderator is needed to steer and build up a good rapport with group members, there are known limitations in using this methodology.

For instance, Morgan (1997) has identified the moderator's *"heightened visibility"* (p. 14) to overly direct and subsequently influence the group's interaction, given questions are often targeted by the researcher's (and/or their employer's) own interests. The presence of the group is also known to increase the tendency for more conformed and extreme views (ranging from mainstream or uncontroversial comments to be readily agreed with, to exaggerating opinions to impress or gain approval from others). This obviously raises the level of uncertainty over the accuracy of what participants say (Morgan 1997). Additionally, levels of involvement can also significantly vary across individuals (from being too high or low), with the risk of more dominant members monopolising and biasing the group's feedback. With further concerns over the limited amount of effort assumed acceptable to organise and run a focus group, these issues can be seen to 'camouflage' the validity and rigour of the methodology in question (Kroll et al. 2007).

The distinction between focus groups and in-depth interviews are less easy to define, given they

are both forms of interviewing (Crabtree et al. 1993; Morgan 1997). Mann and Stewart (2000) describe focus groups as being about *"model and consensus building"* (p. 99), in gathering information about many people's interaction, rather than just one. Focus groups can therefore be seen to have less depth than individual interviews, which place more onus on the individual respondent to elaborate and expand on answers. This can be considered particularly useful in situations when group interaction could inhibit responses. Alternatively, Morgan (1997) argues focus groups are a good means of comparing differences in opinion and experience, in contrast to the equivalent time required to run and analyse data from separate interviews (which he argues unlike focus groups don't allow for the same degree of participant control).

Studies that have explored the process of using focus groups with older people are extremely limited (as are those that have centred on disability *per se* [Kroll et al. 2007]). For example, focusing on ageing adults, Barrett and Kirk (2000) found that older volunteers had noticeable difficulties in maintaining attention, were distracted by irrelevant information and easily fatigued. Similarly, Lines and Hone (2004) found that older people are more difficult to manage, given that they are more inclined to drift away from the topic of conversation. Consequently, they argue that any focus group undertaken has to be highly structured and relatively small in size. As such, generic guidelines include the use of simple and short questions, large type size when using written material, good lighting and appropriate seating arrangements for those with poor hearing (Barrett and Kirk 2000). Unfortunately, none of these recommendations give much insight into how to elicit information from older adults in the design of new technology. As a result, it remains unclear how best to modify these interviewing techniques to achieve this.

4.2 Overview of the study

Given these limitations, this study aimed to identify the challenges involved in gathering requirements for novel DITV applications using 'traditional' interview and focus group techniques. Both small focus groups and one-to-one interviews were used to investigate these issues in more detail, with the aim that feedback gathered from these sessions would formulate

the basis for early prototype work. Similar to what Bontoft and Pullin (2003) describe as opening an '*emotional channel*' of communication to users, by focusing on their aspirations and needs, the objective was to cultivate spontaneity from older participants through the use of a series of short and semi-structured questions. While not an exhaustive list, subjects and questions included:

- **Technology in the home**: *Do you use a computer? How often do you use it? What kind of activities do you use it for? Do you have digital television? What do you think it means?*
- **Hobbies and interests**: *Are you part of any social or recreational groups? Do you have any hobbies where you collect things? Do you share these objects with other people? How do you organise the information you collect?*
- **Objects of importance in the home**: *What are the things in your home that are special to you? What would it mean to not have these things? Are there any important possessions which you no longer have?*
- **Communication and contact with family and friends**: *What are your main ways of communicating with other people? Do you have any family at a distance, maybe in a different country? How do you keep in contact with them?*
- **The digital television platform**: *Can you see any more uses of using digital television beyond watching more programmes? What advantages, if any, can you think of having access to electronic information via the television? How would you feel about sharing information with other people through it?*

Early ideas for application areas were loosely centred on exploring the means to enhance the lives of older people by stimulating and prompting interaction in the home, in order to give them a greater sense of presence and involvement in the lives of those around them. This included the use of video conferencing techniques to allow viewers to either chat or send messages about different aspects of TV programmes they were simultaneously watching, or

indeed without reference to any TV content. This would allow participants to not only receive, but also to send and forward information to other members of their social circle (e.g. friends, relatives or care workers). Technically, this is supported by the storage of multimedia content via a local set-top box or remote server facility.

Previous research has looked at social aspects of two-way television interaction via voice and graphical overlays (Coppens et al. 2004; Vanparijs et al. 2004) primarily aimed towards 'techno-oriented' audience groups. Examples also include artistic works related to what Marzano (1995) describes as 'expanding TV experiences', by enriching aspects of daily living within, and beyond, the home environment. As part of this process it is important to emphasis that none of these early ideas were 'fixed', as the author was conscious not to bias or limit participants' responses for future work.

4.3 Procedure

Approximately twenty volunteers were selected from a panel of over 200 older people associated with the School of Computing, and were sent a short letter stating the details of the PhD project in lay terms. Participants were provided with information on the duration and purpose of the study. To maximise the use of the database panel, individuals were chosen primarily based on a) their locality to the university, and b) limited involvement to previous research projects. Those who responded with interest were then telephoned by the author to organise a date and time of meeting. Altogether 15 people, all aged over 60 years (4 males, 11 females), took part in the study, including one married couple and two similarly aged sisters. Three of the participants took part in one-to-one interviews, while the remaining twelve were divided into four focus groups (consisting of between 2-4 participants). Sessions were conducted between June and August 2005, and each lasted approximately 90 minutes.

At the beginning of each session, participants were given a verbal explanation of the aims and objectives of the research, and were asked for informed consent in compliance with the

University of Dundee's ethical guidelines. Both individual interviews and focus groups followed the same procedure, and were both conducted in a private meeting room within the School of Computing. All conversations were recorded onto a digital dictaphone, as the author took on the role of moderator/interviewer to facilitate discussions.

Following the introduction, participants were then asked to respond to a broad set of questions related to their general experience in using PC and DITV technologies. Given these would significantly vary from individual to individual, this was thought a useful means of 'warming up' the discussions. Open-ended questions were then asked with regards to participants' lifestyles, including hobbies and self-interests, and communication with family and friends. In particular, rather than focusing on technology *per se*, participants were encouraged to describe aspects of themselves, and how the technology could fit within their self-interests (rather than visa-versa). To avoid any unnecessary disruption in the flow of the conversation, all questions were designed to be short, clear, and well sequenced, with the author further elaborating on them when required. Finally, volunteers were given the opportunity to reflect on comments, and to ask any further questions they thought appropriate in relation to the project.

In terms of data analysis, audio files were first transferred to a hard disk, before being partially transcribed by hand, highlighting and indexing key segments of text, both to identify underlying themes and patterns in participants' responses. For interviewing, similar to what Oppenheim describes as *"develop*[ing] *ideas and research hypotheses rather than gather*[ing] *facts and statistics"* (1992, p. 67), it is important to re-emphasise that these early sessions were primarily designed to gather valid ideas for developing low-fidelity prototypes, rather than a more explicit analysis of what was discussed.

4.4 Results

4.4.1 Technology usage

Amongst the participants, interests and understanding of computer technology was mixed.

Noticeably, there were strong distinctions between skilled users, using computers to browse, organise, buy and sell, and share information, compared to those who (lacking the same experience) limited their usage to very specific applications. Given the high number of volunteers with some form of 'computer experience', only three people were reported as being computer illiterate (even though one person had used a PC as part of her career). In each of these cases, despite knowing friends who were keen users, there was a general lack of interest in wanting to learn 'at their age'.

In relation to television usage, participants claimed to be very selective in their viewing, and although nobody was resistant to watching television *per se*, a handful of volunteers did favour listening to the radio or reading, particularly during the day time. In these occasions the television was seldom (or never) used just as background noise, and proved difficult to watch for one individual who reported having a cataract in her left eye. Overall, approximately half of the participants mentioned having digital television, of which the majority reported to own terrestrial Freeview. Incentives to convert and buy DITV included better picture quality and sound, and more channel choice (benefits recognised by the majority of volunteers). However, many adopters were critical of the high number of repeated programmes, which were not perceived as being value for money. Furthermore, it was identified that, apart from Teletext and the electronic programme guide, no extra interactive services, or accessibility features such as subtitles or audio description were used. For the non-adopters, it appeared that many individuals were content with the availability of the five channels on analogue television, and/or were sceptical of both the costs and complexity involved in setting up new equipment in the home. Furthermore, while the majority of volunteers had heard of the DITV switchover, few were aware of what this terminology actually meant. In assuming it had something to do with the 'red button', one participant described how 'digital' to her implied pressing something with a 'digit'.

4.4.2 Memorabilia

One of the main points of discussion during each session was the focus towards objects of

importance in the home. These varied from photographs of places and people, to books, music, furniture, jewellery, porcelain and even ‘the cat’. However, objects related to family were reported to have particular sentimental value. As such, personal accounts were given with respect to memorabilia inherited from parents during the Second World War, including photographs and personal diaries. Descriptions also included quite unusual objects, such as a cherished saucer engraved with three stamps, given to one participant by her grandfather shortly before he emigrated overseas.

Related to the idea of collecting items was the hobby of making a paper scrapbook, of which a few participants reported doing when they were children. In particular, one person mentioned how she would buy ‘scraps’, that is, sets of paper objects, like dolls or boats, to cut out and use, or swap with friends. While most people had grown out of this hobby, one participant went on to describe how she continued to make scrap books related to her personal interests, such as collecting theatre programmes, writing poetry and personalising photographs. However, she emphasised that this was a far less ‘creative’ process to when she was a child.

Furthermore, given the active day-to-day lives of many of the volunteers, there was also an element of wanting to share experiences with other people. For example, one person described how over the last 20 years she had given various slide presentations to local women’s groups of photographs taken on trips across Australia, New Zealand and Iceland. Although this didn’t involve the use of any computer equipment, only a slide projector, she enjoyed reminiscing and talking about these experiences with other people. In another case, financial incentives to sell valuable items online led one retired couple to start electronically documenting family memorabilia on their home computer. This comprised of photographs and articles from wartime broadsheet newspapers, which they reportedly stored on two floppy disks.

4.4.3 Digital scrap booking

Extending these ideas further, the term *digital scrapbook* was used to discuss the possibilities of

sharing information via the television. However, beyond the practical difficulties of getting individuals to conceptualise this idea, reactions were somewhat mixed. To illustrate, one volunteer was reluctant to share anything with other people on the television, describing how she had already thrown away a large amount of personal possessions, such as letters from her deceased husband. When asked why, it became apparent that items 'stored' on the television were thought to be open to a certain amount of misuse, given it was assumed that content could be accessed by other television viewers. Describing how a friend had recently been burgled, the uncertainty over the security of information became a prominent concern. Alternatively, it was the enjoyment of being able to assemble 'bits of paper' into a photo album, or sit around a table and physically touch the images, which was considered to be far more personal than having them replicated on a two dimensional screen.

4.4.4 Social communication

Of the further issues discussed, 'digital' contact with distant family was a particular interest, as mediated communication was often limited to the telephone and/or in some cases email, with a few individuals still writing letters to siblings or cousins a few times a year. In each of these cases, photographs were often the only direct visual link to 'seeing' family members, as many were reported to live overseas in countries like Canada or Australia, as well as other parts of the UK. Consequently, individuals remarked on the benefits of seeing the person in question and being able to wish them a happy birthday, rather than simply send them a birthday card. A visual facility was also thought useful in situations like a school reunion, in giving an absent person the opportunity to join in the conservation. However, the option of communicating through the television was not without criticism. Most notably the concerns over the intrusiveness of being interrupted by a 'TV caller', who it was assumed would automatically appear over the programme being viewed:

> *In a way that is an invasion of your privacy… I don't want people popping up when I am in the middle of something…. I don't want to be disturbed, that is why I so object to phone calls in the middle of things.*

Additional interest was raised over the ability to view day-to-day appointments on the television. However, this concept of a 'virtual diary' left many people unclear of how it would be set-up and implemented. In particular, its lack of portability compared to using a 'paper diary' was seen as a noticeable limitation for some of the female volunteers:

> *It seems like a nice idea, but I would never not have my diary... I know I won't accidentally blitz it unless I rub it out.*

4.4.5 Direct/indirect prompting

In terms of the process of eliciting requirements, one of the main problems identified from the discussions was the difficulty of getting users to conceptualise the types of new activities that could be performed through digital interactive television. Simply asking them what they would like to use the technology for (beyond watching more programmes) had noticeable limitations. In the case of the digital scrapbook concept, while individuals were engaged by the overall idea, they clearly found it difficult to comprehend how photographs could, for example, be 'transferred' onto a television set, such as their own. Similarly, more indirect approaches that attempted to engage participants by either illustrating the interests of other user groups, or more readily their own, also found a number of limitations.

To illustrate, discussions on the physical collection of objects, particularly the organisation of photographs and photographic slides, led some volunteers to explain how downsizing into a smaller property had created the need to reduce the amount of 'clutter' in the home. Using this feedback, participants were then asked if they saw any advantages in storing these items electronically. A number of ideas emerged, ranging from the preservation of old and deteriorated images, to electronically documenting valuable items to 'pass down' to children and grandchildren as family mementos. Following on, using the simple (non-technical) analogy that these items could be accessed via digital television, participants' were then asked if they saw any obvious advantages in using this technology. Of the limited feedback received, one idea raised was the possibility to record and store personal stories related to old family photographs,

particularly in reminiscence of deceased parents, who were described as being the ‘last link to things unknown’. However, beyond initial reactions, when prompted further it became apparent that unlike the familiarity of documenting something by hand, individuals were more concerned over the amount of ‘complexity’ involved to interact with something on-screen, rather than ‘how’ they would like to interact with it. In this situation, assumptions that the technology would be difficult and time consuming to use, led some participants to reject the original idea proposed.

4.4.6 Attitudes towards technology

Remarks towards the complexity of using digital technologies were reflected in the wider attitudes of volunteers, who were often very self-critical and quick to devalue their own understanding of related interactive systems, particularly in terms of highlighting their deficiencies (i.e. what they couldn’t do) rather than emphasising their strengths. Despite a lifetime of acquired knowledge, many participants dismissed being referred to as an ‘expert’, assuming this required a high level of computer competency. For novice computer users, a lack of understanding of related terminology left some participants feeling penalised for not ‘knowing the language’, particularly the notion of learning from an ‘system of (undefined) initials’ (i.e. technology acronyms and abbreviations), which the media industry was blamed for perpetuating. Amongst the variations of experience, for some, the ‘give or take’ attitude towards using computer-based systems was reinforced by comments which reiterated the difficulties of understanding basic procedures, such as sending an email attachment, or independently setting-up new equipment. Frustrated by the time taken to complete computer tasks compared to the equivalent of doing something by hand:

> *I find myself getting irritated thinking I could of written the whole thing in the fraction of the time it has taken me to do this, but I can appreciate it is because of my lack of skills.*

4.4.7 Technological familiarity

The studies revealed a strong tendency to compare ideas based on previous experience with known technology. Typically, one of the greatest criticisms was the perception that the ideas discussed could already be done on a desktop computer. For example, some volunteers having mentioned owning a digital scanner and camera, hinted at the redundancy of viewing photographs on a television screen, given the feasibility of using a PC. This also related to brief (and to some degree vague) descriptions of using familiar computer-mediated programs, such as instant messaging clients or email to facilitate communication with other people. In each case, it was assumed that these desktop applications were directly applicable to the television domain, which was assumed to be highly suitable for TV interaction. At the same time, for those people without the same technological experience, it reinforced the problems of trying to gather ideas for new applications, based on unrelated mental models, and reconfirmed the challenges of designing for those people who acknowledged having grown up predominately understanding the 'written' word:

> *These emails I have vision of them winging their way off into the ether, I never quite know where they go, or if they don't get to where they should go where are they. I mean I know it's ridiculous and my head tells me it's nonsensical, but that is still the kind of attitude we still have because we weren't brought up with computers. And it is this business of not knowing that the message has actually got to where it is going, that's a worry.*

4.4.8 Practical issues

Technical problems were experienced in documenting early sessions, largely accountable to the author's inexperience in conducting focus groups and one-to-one interviews. In three of the seven sessions a significant amount of data was lost due to technical glitches with using the digital dictaphone (further attributed to a noisy environment, and poor microphone quality). This became doubly problematic as the author's absorption in facilitating discussions meant field notes were rarely taken. Less then ideal, to compensate for human error, notes of the conversations were hand written from memory shortly after they had been completed.

In terms of reporting focus groups, Stewart and Shamdasani (1990) have illustrated the problems of facilitating group dynamics (e.g. in accounting for differences in demographics [i.e. age, sex, and income], personality and group cohesion). As such, with older people being no exception, there were members who tended to ramble and drift away from the topic of conversation, compared to those who either overly agreed with the group, or remained quieter and self-reflective during discussions. Consequently, the idea that older adults tend to 'wander' from the topic of conversation (see Line and Hone 2004) seems not an uncommon experience in conducting focus group research. More specifically, the problems reported of older people maintaining attention and becoming distracted by irrelevant information during group discussions (Barrett and Kirk 2000; Lines and Hone 2004) were not identified in this study. This may be accountable to the small group size, or duration of interview sessions, but the participants were found to be engaged throughout discussions. These issues are known to affect people with cognitive functional impairments, such as memory loss (Kroll et al. 2007), however they posed little concern to the sample of 'healthy' adults used in this study.

In comparing this multi-method approach, the one-to-one interviews allowed for a greater level of in-depth probing, while the focus groups provided a larger amount of interchange and breadth of discussion amongst its members (allowing the author to take a more observant role). With the few exceptions previously highlighted, participants from both types of studies were comfortable in talking with the facilitator, and in developing responses in relation to the questions asked. Given the nature of this work, further investigation may warrant more significant differences, however they were not clearly identified here.

4.5 Conclusion and discussion

Overall, the individual interviews and focus groups reconfirmed the challenges of early requirements gathering in the elicitation of new ideas, without forcibly influencing opinions or presenting users with more formalised design concepts. One of the great weaknesses of the open discussion approach was the difficulty of getting volunteers to conceptualise possibilities from

the hypothetical presentation of ideas. As a result, due to the lack of data gathered it was felt there was not enough new information to enable early prototype development work.

Related to what van der Veer and Puerta Melguizo (2003) describe as users basing mental models of present situations from similar past experiences, it seems unsurprising that direct comparisons in one way or another were made to the desktop PC, given the high number of computer users. However, the difficulty was that in applying unfamiliar, analogous concepts to a familiar domain like television, many individuals struggled to infer models for new applications, based on fragmented experience and knowledge of associated concepts. Consequently, without understanding the 'fuller picture', these abstract ideas were seen to hinder participant's ability to assess the application's overall applicability. In particular, it is felt that these results may have been even more noticeable if less technological experienced volunteers had been used. This is an important issue that needs to be considered in establishing a more representative user sample for future studies.

Given these findings, one option to improve the effectiveness of interview techniques might be the use of visual aids or prompts to facilitate and stimulate more insightful ideas. In focus groups, Krueger and Casey (2000) describe the use of picture sorting, in which volunteers are asked to select and give an opinion on a particular situation depicted in the image. Visual aids are also commonly used in marketing research as a means to circulate opinions about a product. The problem is that in the context of trying to define something which is largely undefined, it remains highly speculative how best to visually demonstrate something to an audience so as not to limit or mislead perceptions. Furthermore, of the known focus groups studies undertaken with older people, Goodman et al. (2004) found the use of photographic probes to be ineffective in encouraging open discussion. In this case, while they suggested these limitations may be accountable to the design of the tasks, such examples reconfirm the problems of using such tools.

Finally, in considering this study as a ‘pilot exercise’ in working with older adults, it reiterates the need for good research practice, ensuring that the basic design procedures are set in place. Namely that all digital equipment is working correctly, and if necessary backed-up using additional recording devices to make sure no further data is lost during the project.

5. The use of Forum Theatre to explore the acceptability of DITV applications

5.1 Introduction

Having identified the limited amount of ideas raised from the small focus groups and individual interviews, it was clear that more imaginative methods were required to challenge older peoples' perceptions and understanding of new technology. In further pursuing the option for using 'visual material', a decision was made to investigate ways in which live theatrical performance could be used to promote greater end user involvement in eliciting possible solutions for novel TV-based applications appropriate for this user group. As such, a particular theatre genre, *Forum Theatre*, was used to establish a 'common ground', by allowing members of the audience to reflect upon and engage with actors and other members of the audience about the characters' thoughts and actions in regard to new DITV applications.

Established in the 1970s by the contemporary playwright and director Augusto Boal within his 'Theatre of the Oppressed' movement in Brazil (Boal 2000), Forum Theatre is an applied form of interactive theatre where a group of actors conventionally 'act out' an example of an issue in one or more short scenes. A discussion with the audience is then conducted through the use of a skilled facilitator, who assists in generating debate and encouraging group participation. During the performance, the actor, or the facilitator, may stop a scene to elicit information or ask for assistance from the audience. The audience can also question the actors who remain in role. Scenes may be improvised with the audience, who may request a replay of certain actions, or make alternative suggestions. Theatre can thus provide a natural outlet for protagonists and antagonists to work together towards solutions to challenges, and encourage users to take a creative role by engaging in discussion with the various stakeholders, rather than simply being observed.

More recently, studies by Brandt and Grunnet (2000) and Tiitta et al. (2005) have explored the

use of these dramatic techniques. These have included the use of dramaturgy to focus on human aspects of fictional personalities and lifestyles in work situations, in addition to materials such as photo diaries to capture aspects of everyday activities. Through the use of theatre improvisation, drama is seen to emotionally and reactively engage the audience with contrasting experiences (Salvador and Howells 1998). This is noticeably different to the use of more 'traditional' scenarios and personas, which have been criticised for 'statically' communicating with their intended audience (see Kantola et al. 2007), as well as lacking in personal engagement to more credible and realistic story-based approaches (Strom 2007).

The use of dramaturgy and interactive narrative has been used more specifically to educate, open dialogue, and facilitate discussion on design related issues in the development of technology for older adults. Examples include the use of dramatised stories portrayed through video to assist in the development of an automated fall monitoring system to support older people within their homes (McKenna et al. 2006). Short scenarios, written by a professional script writer and recorded with professional actors aimed to "*promote the conflict between characters*" (McKenna et al. 2006, p. 34), both to illustrate how the system might work, and the consequences of errors which could occur during its usage. The researchers reported that the familiar context and believable dramatic tension in the videos were extremely valuable in facilitating and stimulating discussions with groups of potential users. These discussions successfully engaged the audience, producing a wide range of rich anecdotal information in relation to individual experiences, and elicited a number of important unpredicted social and technical issues within the system.

Furthermore, video has also been found to be a powerful technique in educating designers in the development of computer-based systems for older people. Dramatised stories were included in the UTOPIA[27] project, the primary aim of which was to develop techniques to inform, and correct, the 'mind sets' of designers concerning the needs of older people (Carmichael et al.

27 Usable Technology for Older People: Inclusive and Appropriate.

2005; Newell et al. 2006). A series of short videos aimed at addressing the issues older people have in using modern technology formed the 'UTOPIA Trilogy'. These studies involved developing scenarios about the target group's experiences with technology. The success of these approaches resulted from the ability of the stories to illustrate the 'human impacts' and 'real world' problems faced by many older people in using computer interfaces, through a process that allowed audiences to empathise and readily identify with the characters portrayed (see Carmichael et al. 2005; Newell et al. 2006). These videos proved to be a very useful method in provoking discussion, and addressing sensitive issues with designers.

5.2 Overview of the study

Following the success of these video-based projects, a drama-based methodology inspired by Forum Theatre was used as a means to explore ideas for the early development of DITV applications for older people. Live theatre was used to identify the acceptability of a number of social activities presented to participating audiences, with the information gathered during these sessions aiming to inform ideas and narrow interests for early prototype development. It was believed that involvement of the full range of theatre professionals, with experience in theatre genres that involve audiences in novel ways, was required to create empathy and interaction.

A series of short stories illustrating the use of digital TV applications were developed by a script writer (the Leverhulme Artist in Residence at the School of Computing) in conjunction with the author. Through an iterative process, three short plays were produced to provoke discussion on various types of social interaction via DITV (see **Appendix G**). These were developed over a four week period, during which time the author regularly consulted with the professional script writer to ensure an accurate and detailed portrayal of each scenario. Content for the plays was based on the feedback from the focus groups and individual interviews in study 1 (see **Chapter 4**). In particular, given the limited amount of ideas generated from this study, a careful attempt was made to include both positive and negative criticism, so as to challenge preconceptions, expand on early conceptual ideas, and to verify understanding of the activity areas presented.

Table 3 illustrates the scenarios. Overall, each drama scenario lasted approximately seven minutes, with close attention paid to the scenes, storyline and dialogue used, as each story was carefully designed to:

- use fictional characters and embody ways in which users might act in the context of the novel technology;
- identify interaction issues audiences may experience, while carefully avoiding any technical details or jargon that might confuse participants;
- be short, concise and open-ended so as not to resolve any situation;
- include the standard characteristics of good theatre such as, tension between characters, humour, and resolution;
- avoid the use of working prototypes to depict the applications, instead relying on a series of props, such as a digital television set, a web-camera, various household objects and a video projector.

Title	Description
Communicating with family and friends	Peggy, a widow has just bought a new digital television with an inbuilt video camera so that she can use the new 'chatting service' with her daughter and family who live in another part of the UK. A younger neighbour helps Peggy to operate the system.
The memory box	A few years later. Peggy is moving from her family home into a sheltered flat. She has to give away many items, which remind her of the past. The sense of loss is managed so much by the interactive camera facility to make a 'scrapbook of memories', which she can take with her.
The TV reminder	Peggy always forgets her son-in-laws birthday and is frantically looking for a piece of paper with the date. When she sits down to watch the news on TV, a reminder message sent by her daughter appears on the screen.

Table 3: Description of scenarios

Finally, once the scripts were complete, three days of stage and technical rehearsals were undertaken with two professional actors[28] and the script writer (also experienced as a theatrical director/facilitator) prior to the plays being performed to audiences of older people. The actors were chosen from a local theatrical group based on their experience and ability to match the

28 In total three actors were used for the performance, however the third actor, a teenage boy was not present during the stage performances as his role was pre-recorded onto video.

physical characteristics of the characters depicted. As such, one of the actors, playing a retired widow, was aged over 65 years, while the other, taking on the separate roles of a younger neighbour and daughter, was in her late 20s.

5.3 Procedure

Having recognised the high number of computer users from the first study, a careful attempt was made to get a more representative sample of older volunteers. In collaboration with a research colleague, a joint press release was distributed through the University of Dundee's press office, looking for more reluctant and technological inexperienced volunteers (see **Appendix A**). Published in a number of local newspapers, including nationwide coverage on the BBC News website[29], the authors ensured a corresponding contact number was included. Those people who responded with interest were then asked to leave their contact details via voice mail. Shortly after, they were telephoned by the author who briefed them about the PhD project, as well as asked them a number of short questions to assess their availability and understanding of digital technology *per se*. Subsequent written conformation was sent out to confirm their participation.

In addition to using the database panel (see study 1), in total, 45 people were recruited, all aged over 60. Participants were divided into two groups - those who had had some experience in using a computer, and those who had never used a computer before (see **Table 4**). Given this variation in technological experience, these two groups then attended separate theatre sessions. From the background information received, it was identified that 31 people (69%) reported to have had digital television, of which 16 (52%) classified themselves as computer users.

29 http://news.bbc.co.uk/1/hi/scotland/4588322.stm (Accessed 12 May 2008)

Group 1: Computer users				Group 2: Non-Computer users			
Male: 9		Female: 13		Male: 8		Female: 15	
Mean age: 71.7	S.D: 4.26	Mean age: 67.5	S.D: 6.26	Mean age: 75.5	S.D: 4.44	Mean age: 68.6	S.D: 5.71

Table 4: Group details of participants

For the live performances, both sessions were conducted in the Wolfson lecture theatre, School of Computing. Apart from members of the audience, they consisted of two actors, one facilitator, the author and a camera operator (to help record the two events). In this case, the facilitator was also the script writer who had agreed to assist in the running of the sessions. Both sessions were recorded onto separate audio and video formats using four video cameras and one separate boom microphone. Props such as household furniture and objects were also used to depict a home setting, while digital equipment included a LCD television, set-top box and a web-camera carefully positioned on stage. Additional features also included a change of clothes for the actors, as well as the use of a video projector for depicting aspects of a scene in the first play. This consisted of a video of a grandson in his living room (pre-recorded in the actor's home) talking to his grandmother, to give the audience the illusion of a two-way, real-time conversation through the television. To maximise the use of this space, it was displayed across the back theatre wall, behind the stage, to be played on cue.

Each session began with the author welcoming volunteers, providing an overview of the session and obtaining informed consent. The facilitator then presented a series of open-ended questions in relation to the audiences understanding and everyday use of technology. Once complete, the first play was then introduced, and at key points in the script, interspersed with group discussion. For example, after the actors had introduced the topic of buying a new digital television set, the facilitator 'froze' the scene to discuss aspects of the digital switchover with older volunteers. In resuming the story, a more extensive group discussion preceded the concluding scenario. This was done to gather general feedback, identify more specific

interaction issues, and allow audience members to share related experiences. A similar pattern was repeated for the remaining two scenarios, which were individually rounded-up with group discussions with the author, each lasting approximately 15-20 minutes. During this time, audiences were encouraged to 'hot-seat' the actors who stayed in character; i.e. to pose questions in relation to what they had done, and the problems they may have encountered in using the technology. Finally, to conclude, participants were asked for their final thoughts on the event and thanked for their involvement.

Analysis of the results was undertaken using open-coding techniques from Grounded Theory (see Strauss and Corbin 1998), a methodology used to derive meaning from the systematic gathering and analysis of qualitative information. As a first step, all data from the digital recordings were transcribed. Avoiding non-verbal communication and gestures, as part of the analytic process, patterns and categories in audience behaviour and responses were defined and subsequently analysed. This method of examining the data provided a useful means to generalise, and then discretely compare similarities and differences between responses from the two different groups.

Figure 7: Interactive theatre in practice. (*Top*), audience members watching and interacting in discussion; (*second row, left*), the actor, author, facilitator and camera man; (*second row, right*), audience and author; (*third and fourth rows*), the actors in performance.

5.4 Results

The sessions raised a number of important issues. Firstly, in terms of DITV, members from both groups demonstrated varying degrees of understanding of the digital switchover, of what 'digital' actually meant, and what was required to receive digital television from the different subscription options currently available. With some audience members feeling forced to adopt, vague descriptions of digital (as distinct to its analogue predecessor) included assumptions that it had something to do with 'pixels', or receiving 'dots and dashes'. In other instances (as demonstrated in the first play) it was thought DITV actually meant replacing and buying a new television set. For current adopters, criticism was raised over the costs of having to 'upgrade' and pay more to get additional programmes, with some complaints about unstable and degraded picture quality.

As could be expected, while PC usage was high in the computer group, the mobile phone had mixed popularity amongst both audiences. In general, text messaging was very unpopular amongst participants, limiting functionality to telephoning people when 'out and about', or more specifically in emergency situations. For the more experienced and competent computer users direct comparisons were made between operating a TV-based application and a personal computer. Questions, for example, were raised to whether a reminder service on digital television would work similarly to receiving an email message, or whether digital content could be copied onto a CD-ROM.

Similar to the first study, direct comparisons between PC and DITV technologies led computer users to comment that some of the activities portrayed by the actors, such as chatting with family, or sharing digital photographs could already be done on a home computer. By comparison, given the novelty of ideas, many of the inexperienced computer users remarked on the perceived advantages of such activities, not only for themselves, but for other friends and family members.

Of the three activities presented, both groups favoured the first scenario, and the possibility of some kind of two-way communication system, predominately for staying in contact with friends and family at a distance. In recognising pros and cons in all the activities presented, a more detailed summary is given below.

5.4.1 Visual communication

The ability to visually communicate with other people via the television was thought to be advantageous in keeping in touch with friends and family at a distance, particularly with grandchildren and elderly relatives seldom seen. Real-time communication was considered a valuable means of assessing the well-being of an individual, such as seeing the 'expressions on a person's face' rather than just a 'disembodied voice' (envisaging this facility would allow for the engagement of day-to-day activities with the other person). In particular, a visual link was favoured for providing reassurance both for themselves, and other family members of the well-being of the person in question.

> *Far better way than stilted emails and or letters, written in one mood and received in another.*

Furthermore, the enactment of a grandchild being too busy to speak to his grandmother because he wanted to watch a programme was praised for its realism, with similar experiences identified in telephone conversations. In recognising the potential benefits of a two-way medium, a number of practical issues were generated in relation to social etiquette. For example, participants from both groups were concerned over the intrusiveness of such a system, with questions raised if someone could 'automatically' appear on the screen without some form of prior agreement with the participating party. As a result, there was agreement from both groups concerned that, for a two-way visual communication system to effectively work, some form of preventative measures, or pre-conditions, would be necessary to stop a caller from contacting a friend or family member while they were watching a television programme.

> *I think it would be awful if that could actually happen, that your privacy could be invaded just because somebody was going to push a button, somewhere else. There could be all sorts going on.*

Protocol issues associated with social etiquette and privacy were also identified. An illustration of this included the use of the mobile phone, which was believed to have had resulted in the perception that individuals were contactable all the time. As such it was assumed that older people were more susceptible to the potential 'intrusiveness' of this new technology, given the social obligations perceived by older generations in having to answer a telephone call when it rings. This led to recommendations for a form of messaging service, similar to using a telephone answering machine where users could prevent, or even postpone, having to answer an unwanted call on the television.

> *...most of us were probably brought up on a kind of etiquette, that you did not contact people at certain times of the day because that's their private life... and this seems to me that this is like the mobile phone technology, where people can access you at random, whether you want to be in contact or not, and your almost moving to something like the telephone preference system, or a screen system if you want to clear areas of your life that are not defined, or equally you don't want to intrude on somebody else's. And I get a little bit worried about the problem that this notion that everyone has to be accessible to everyone and everything all the time.*

Use of the overriding system was also thought to be dependent on its cost. Unlike their counterparts, members of the computer group commented on the negligible costs of using home broadband and web-camera facilities to speak to friends or family overseas. Questions were therefore raised over the expense of using an equivalent service on digital television, which was thought to be comparable to the costs of using a personal computer. In addition, the uncertainty as to how the digital system would operate raised concerns over if, and how, someone could effectively access and obtain personal information from their television set. As part of the discussion, some participants recounted that they had experienced and, in some cases been charged for, 'cold' or unwanted calls, despite, being ex-directory or registered on the Telephone

Preference Service[30] (a concern that was raised by members of both groups). In particular, more experienced computer users, associated this form of unsolicited messaging as a type of 'internet spam', and asked about the feasibility of an equivalent spam filtering mechanism as found in computer security software. While others were more concerned over what procedures would be available to prevent 'bogus' or unwanted calls from commercial advertisers, without blocking someone they knew from contacting them in an emergency situation. To combat this issue, one suggestion was simply to have an icon displayed on the television screen indicating the type of person calling through.

5.4.2 Capturing and sharing memorabilia

From the story line, similar experiences were drawn to what was described as the 'trauma' of an older person having to downsize and move into sheltered housing. On a personal level, the option of building up a 'catalogue of objects' (i.e. personal possessions) was thought of as a very useful means to prompt and stimulate conversation with older relatives, housebound or in social care. Beyond the 'mechanism' to take photographs, this included the option to 'capture movement' and 'voice' by video recording.

> *I know I had an elderly aunt in a care home… that would have been something great that we would have actually talked about, because its difficult sometimes when your visiting, cos you run out of things to say, cos they don't have any new topics of conversation. And that would be something not only that you talk about, but it would stimulate their memories as well, so I think it would be a great tool for that.*

Particularly favoured by the non-computer group, suggestions included taking a still picture from a played back video, as this seemed the most practical way known to record both. Concerns however were drawn towards the capabilities of a very old person to self operate the system independently without some kind of additional supervision.

30 The Telephone Preference Service (TPS) allows individuals to freely opt out of receiving unsolicited sales and marketing calls. Originally introduced in the UK in 1999, this legislation is now part of the Privacy and Electronic (EC Directive) Regulations 2003.

By contrast, members of the computer group were far more critical of the technical capabilities of the 'facility'. Questions were raised to why the character didn't simply transfer, or back-up the images onto a CD-ROM (similar to using a computer). Furthermore, with the option of importing images into photo-editing software, it was also questioned whether an equivalent DITV system (with web-camera) would produce the same 'superior' results as using a separate high quality digital camera. If not, it was thought to be an 'unnecessary technology'. However, this is not to say that no advantages were recognised. The built-in web-camera was thought particularly useful in capturing and storing images of household objects of financial value (such as for insurance purposes), in the event that these items were actually lost or stolen. However, despite more technical 'know-how' within the computer group, assumptions that multimedia would be physically stored within the actual television set (rather than STB), led to uncertainties to whether information would be lost if a new television was purchased, or older set accidentally damaged.

When directly asked how they would organise multimedia, such as photographs on a TV system, for the non-computer audience, vague suggestions centred around some kind of alphabetical categorisation. This was noticeably different to the computer group, who by contrast, made quite strong comparisons to the desktop PC, with suggestions for cataloguing items using a 'filing cabinet' feature, or thumbnail sets listed on-screen.

5.4.3 Personal reminder

Members of both groups acknowledged that they wrote memos and personal reminders. As an extension of these current practices, it was suggested that a reminder system on television could be a useful means for keeping personal appointments and scheduled tasks such as 'putting out the bin on Thursday', or 'paying for the car insurance'. In both groups, it was assumed, for example, that the system could automatically start when the television was switched on in the morning, and like a paper calendar or voice mail on a mobile phone, list the reminders/activities of the day. A feature seen to have real value for 'older' (i.e. older than themselves) individuals

for daily prompting activities, such as taking medication, or attending a doctor's appointment.

However, there was some apprehension about how easy it would be to set up, store and access information from the television, particularly given existing DITV services were criticised for being slow and time consuming to operate and respond to remote control input. This was argued would only increase the speculation that something had gone wrong, given analogies were made that these messages were being sent off, somewhere. Others felt that they didn't use the television enough to warrant its usage, or regularly forgot to write paper reminders, making it unclear how much more beneficial a digital system like this would actually be. The use of an electronic reminder was also deemed to have limitations compared to a more conventional diary, taking longer to input electronic information than write the message by hand. There were also practical concerns as to whether the system would still work even if the television was switched off. Questions were raised to whether it would need a reminder to 'switch on' the reminder, with the equivalent concern that if the 'batteries failed' the 'whole damn thing' would be lost.

> *Either it's on or not, automatically. I know that sounds a silly question, but that is the sort of thing an old person would say, 'I didn't have the telly on because I was away on holiday for a fortnight'. Would it know the day, or would it know the date. These are the things people need to be reassured about.*

5.4.4 Language and terminology

Participants from both groups reported difficulties in understanding computer-based 'jargon'. For example, terms such as 'buzz words' and 'Hong-Kong English', referring to obscure words and phrases with no clear meaning, were used by audience members to describe their frustration in trying to understand related terminology (defensively arguing *"it's not just idiots that don't understand this stuff"*). Consequently, many felt there was an underlying and implicit assumption that they were simply expected to know what these terms related to, as participants described:

> *A lot of instruction feeds bits of information which are not clearly grouped and are not clearly sequenced, and they are not clear whether something belongs to this*

> *section or something else... and it's this messiness of the feed in of the learning that I think 'foxes' people all around, because they assume things that you don't know.*
>
> *...you are blindly pressing buttons, and I mean what your saying, your saying you don't know this stuff. I was a radar officer during the war, I could take any radar set to bits and put them back together again and it would work, that was my job, and I still don't understand this buzz word stuff which they use in computing, which has grown up round about me.*

Within this context, individuals told stories of how instructions were considered far too dense and complicated to read without the additional support of somebody else who was far more familiar with the terminology to talk them through the various stages, 'step by step'. Based on their mixed experiences in using technology, questions were also raised towards whether manufacturers now had a moral responsibility to inform consumers on how to use and set-up the installation of new digital equipment.

5.4.5 Input control

Within both groups, discussions also included criticism over the difficulty to select and input information from 'fiddly' and complex remote controls. As previously mentioned, some concern was raised as to how very old and mobility restricted individuals would be able to operate some of the equipment illustrated, particularly the movable web-camera. The poor design of remote control handsets was inadvertently reflected by one participant's choice over using an older and chunkier mobile phone because of its larger sized buttons. Given the number of features presented by the stories, it was assumed that "*an awful lot of buttons would be needed on the remote control interface"*.

As such, the use of theatrical performances helped generate a number of novel design suggestions for many of the accessibility issues experienced and foreseen. Many participants were willing to touch-type (albeit very slowly), despite of a lack of experience with regards to SMS messaging on mobile phones. A much simpler, and possibly larger hand control, limited to

three or four buttons, cardboard sleeves placed over the controller to mark clearly defined keys, one select and scroll button option to control all the functionality on the display, as well as alternative keyboard and voice activated devices, such as the use of a microphone attached to the television set were suggested. In each case simplicity was considered a key feature to improving the 'standard' handset.

> *If I carry a telephone, I've got one and it's in the box I have to tell you. But anyway, if I had a phone all I would be using it for would be sending messages, receiving messages. I want one button for one, one button for the other, and off and on, and that's all I need. And yet my phone has got one hundred things, and I don't know what any of them are for.*

5.4.6 Degrees of customisation

In view of the perceived complexities of learning new technology at an older age, comments were raised over the feasibility of starting from a minimum rather than maximum level of functionality in the development of a working STB system - in what was described as a *"good old work horse piece of machinery"*. Questions were raised over the plausibility of tailoring and adapting applications to accommodate a variety of user needs, including options to customise features and limit application functionality. In one case, this approach was referred to as developing a 'modular system'.

5.4.7 Technical feasibility

From both groups, there were practical questions about whether such applications would work on a global scale, whether a conversation could be recorded while 'recording' a programme, if the same equipment would have to be acquired by both sources (or parties), or if an application would run on an existing STB (i.e. without a return path) or through a 'special television'. Concerns were also raised over the reliability of the technology to actually work and send information to where it was supposed to go (given the uncertainties of knowing where this information was being sent), as well as questions towards the speed of technical advancements

in digital systems, and the life span of these relevant technologies.

As previously highlighted in **Chapter 4,** there were clear signs of participants analogously transferring prior knowledge of known technologies often based on incomplete or inaccurate mental models associated with known devices. The following additional examples were drawn from the transcripts:

- **Relative size**: the memory capacity of a device was seen in relation to its size. As a digital camera was described as being a quarter of an inch thick, but able to hold hundreds of pictures, it was assumed that a 'television screen' could hold many thousands more.
- **Physical attachments**: the web-camera mounted on top of the television set raised questions over the feasibility to 'unhook' and move this device around the rooms of a home. Given the portability of a mobile phone, interests were raised in being able to show people a view of a newly decorated kitchen, or summer garden. While the technical capabilities were unknown, it was assumed a cable extension would be sufficient to achieve this.
- **Storage and access**: as previously discussed, it was believed that information would be stored within the television (rather than STB), with access to systems acquired through an associated email address.

To a lesser extent these inaccurate descriptions were often compounded by an uncertainty over how to control the technology, which to some degree can be expected due to the lack of understanding of the associated equipment. However, as reported in mainstream HCI, these fragmented conceptual models of how the system should work, reiterates the extent to which prior knowledge can heavily conflict with the requirements needed to understand a new application.

5.5 Conclusion and discussion

The results of these sessions illustrated the power of Forum Theatre as part of a requirements gathering methodology, which enabled computer literate and technologically naive people to understand and address important issues in the design of undeveloped technology. Overall, this method was successful in stimulating discussion on a range of acceptability issues for new DITV applications, including issues in relation to usability, language and terminology, input control, and security and protection. The theatrical sessions enabled audiences to empathise with the problems experienced by the actors in the stories portrayed, and, in doing so, identify important issues in relation to their own situations. Participants commented particularly on their relief that others had experienced the same kinds of problems with technology as themselves.

The strengths of using Forum Theatre, within the context of a user-centred design practice, clearly relate to the creative abilities of theatre to visually convey ideas of how interactive systems may work, without confusing participants about the technical details necessary to achieve this. Forum Theatre was particularly helpful in the discussion of abstract ideas, which have previously been identified to be problematic for people with limited computing experience. As illustrated in **chapter 4**, of the problems recognised in conducting focus groups, drama, with its ability to present information beyond simple verbal representation (Brandt and Grunnet 2000), has been found to be both emotionally and practically stimulating in the discussion of new design concepts.

It was found that participants could generally relate to the interaction problems portrayed by the actors, including their feelings of frustration and uncertainty, regardless of their understanding of technology *per se*. The emphasis placed on actors to mimic actions with imaginary applications, meant working prototypes were not needed to demonstrate the digital system's capability, and this reduced the danger of such prototypes constraining participants' mental models.

Differences in technological experience within groups (particularly the computer group) meant many of the participants wrongly interpreted aspects of how computer-related technology worked (both in terms of digital TV and PC equipment). Many computer users assumed aspects of these 'imaginary' applications were redundant, given the 'superiority' of using the desktop PC. Consequently, these participants, despite being TV users, either ignored or failed to appreciate overarching differences in interaction and usage, or could only conceive of the potential of applications based on their nearest similar experience (i.e. the computer).

In comparing the issues that emerged from the earlier small focus groups and one-to-one interviews, it is clear that many similar concerns were identified in relation to issues of privacy and access, user input and control. However, one of the key differences between the studies was that the theatre sessions seemed to allow individuals too more readily expand on alternative suggestions or ideas. While this could be accountable to much larger group sizes, and hence more appropriate feedback, answers focused towards aspects of the performance suggest they encouraged more open debate amongst volunteers.

Using Forum Theatre has shown that script writers and actors posses some unique qualities as intermediaries in encouraging older people to become active participants in the development of design concepts. Their skill in dramatising stories and contextualising issues in a recognisable manner of human behaviour and experience can provide some unique advantages. Newell et al. (2006) discuss these issues in greater detail, describing how script writers and actors are able to:

> *... know when to exaggerate for effect, and how to articulate feeling in such a way that it communicates effectively to the audience. In the words of the theatre they are expert in "suspending disbelief" (p.115).*

The author found that the use of actors to respond to audience comments, to think aloud and question their own actions, to show emotional responses, and, within the context of everyday experience, to present generic pictures of users to which audiences can relate, can offer new

avenues to inform and inspire ‘inclusive’ and ‘participatory’ design practices. During this study the actors were approximately the same ages and levels of technological experience as the characters they represented, they were well briefed in their roles, and were experienced in Forum Theatre techniques. At the same time, it was identified that a skilled and effective facilitator is essential to be able to pause and manoeuvre conversations, to encourage open contributions and shared experiences. Forum Theatre facilitation needs to be open, with a facilitator (in this case working with the author) to be able to clarify and pose open-ended questions to encourage audience-centred discussion, without unconsciously directing the topic of conversation.

Given the exploratory nature of the work, some notable weaknesses were identified. For example, some communication difficulties were experienced between the script writer and author in the process of describing scenes. In this case it became quite a challenge for the author to convey ideas in lay, non-technical terms so as to capture the essence of the stories. The collaborative process therefore encouraged the author to think more carefully about the system and its usage context. Secondly, in terms of the actual performances, although many participants were keen to engage with questions and ideas, it was obvious that there was an imbalance of more dominant audience members contributing much more to the discussions than their quieter counterparts. Thirdly, while audiences had a very good view of the theatrical stage, those on the lower rows found it difficult to directly engage with those above or behind them. For future research, it may therefore be more beneficial to conduct discussions in a more informal setting where seating arrangements encourage better group cohesion. Finally, theatre also involves the costs required to script write, perform, facilitate and record a theatrical session. In this study, the costs were roughly equivalent to six weeks salary of a professional engineer. While a relatively small fraction of the total cost of similar system development projects, it should be recognised that there is a significant expense involved in employing trained professionals.

The potential of live performance to inform user-generated ideas in the pre-design stages of new

technology for older people appears to be advantageous for all parties concerned. To reiterate, it was found that the theatre ‘story’ can make future ideas more concrete by enabling people to interpret and extrapolate from their own experiences. This seems very practical in early requirements gathering. As an extension of this study, further research would now be necessary to investigate the method’s appropriateness in the user-centred design process. For example, it may not be equally well suited for very early requirements gathering, or later, more specific, prototype evaluation. As such, a more stringent and refined quantifiable approach would be required to measure its effectiveness as a methodological process. Nevertheless, the use of Forum Theatre has demonstrated its potential as a powerful tool within the context of this thesis.

6. Formulating ideas for the design of a two-way communication system

6.1 Introduction

Given the overarching interest in staying in contact with family and friends, a more focused study was undertaken to investigate how older participants would expect to interact with elements of a two-way television communication system. While a number of key issues emerged from the theatre sessions, there was little exploration into issues governing aspects of interaction and design. In narrowing down the research, this study aimed to examine how older people with limited computer experience would expect to engage with the communication system, in the hope that these ideas would then formulate a basis for early interactive prototypes.

This study draws upon the participatory design work of Muller (1991; 1993), in particular PICTIVE[31], a tool which employs the use of inexpensive office materials, such as coloured plastic pens, stickers and highlighters within a 'rapid' prototype, mock-up environment. This particular study has examined how such exploratory methods can be used to engage older users in the design space. Given that paper prototyping is traditionally seen in the context of evaluating pre-designed interfaces (Muller 1991), this research has explored more creative ways of allowing older volunteers to express their ideas freely, enabling them to build on related technological experience. In comparison to Muller's approach towards bringing together different stakeholder groups with reciprocal interests, including influence from *mutual learning* approaches that place an onus on cooperative prototyping strategies between designers and users within work-based practices (e.g. see Bødker and Grønbæk 1991; Kyng 1991), the present study is more concerned with the processes and strategies older participants employ towards formalising new ideas (rather than the outcomes of the prototypes developed).

31 Plastic Interface for Collaborative Technology Initiatives.

In building upon the direct 'look and feel' approach of PICTIVE, the creativeness of 'sketching' was explored as a visual means of interpreting how older volunteers developed new design concepts. In applying the skills of observation, perception, discrimination and imagination in graphic thinking, Laseau (2001, p. 8) relates its importance to *"show*[ing] *us how we are thinking about a problem, not just what we think about it."* Allowing for subtleties in the representation of information (Laseau 2001), a well-established process within design disciplines, Jaarsvelda and van Leeuwen (2005) report sketching to be an intermediary stage in the development of more formalised solutions.

Specifically, in computing and earlier forms of mediated communication, 'collaborative drawing' has been identified as a powerful means of sharing interaction (Bly 1988). More recently, as a visualisation tool, sketching is seen to support group collaboration, problem solving and work towards complex ideas during a defined requirements gathering phase (Craft and Cairns 2006). In particular, requiring no technical skills, it remains a favoured approach within paper prototyping, both in terms of encouraging open dialogue and refining early design concepts (Snyder 2003). By contrast, Hawthorne (2007), while not specifically critical of sketching *per se*, argues the limitations of low-fidelity prototypes in eliciting ideas with older adults, not only because of their lack of sufficient detail, but also due to the constrained vocabulary of users to express or make appropriate judgements based on the information available. However, given that paper prototypes can actually be quite detailed (considering the variations between the use of compositions, wireframes and storyboard mock-ups), lacking more sufficient literature in this area, it is difficult to assess the extent his findings apply to broader strands of ageing research.

The PICTIVE technique has been developed further by Hornecker (2002) in relation to her work on tangible, 'graspable interfaces'. In what Ullmer and Ishii (2001, p. 579) define as the *"relationship between physical representation and digital information",* tangible user interfaces (TUI) have gained significant standing within computational media, despite recent criticism

about a lack of empirical evaluation underpinning this expanding area of research (Marshall et al. 2007). Similar to Muller (1991), Hornecker (2002) argues that in a cooperative environment, the manipulation of disposable materials in a shared space can reinforce clarity, focus and understanding amongst participants, as she describes how a mixture of verbal and non-verbal actions help orchestrate parallel activities. Seen as a less inhibiting means of collaboration and greater means of concretising abstract models, the malleability of tacit objects suggests a further avenue of investigation in working with heterogeneous groups of older people. It is arguable that tactile interaction and the manipulation of physical artefacts, like bits of card or paper, may add an extra dimension through which technologically reluctant users can successfully articulate new ideas.

6.2 Overview of the study

Conducted in May and June 2006, 14 older people (3 males; average age 75 years, and 11 females; average age 69 years) were recruited from the local area. All the volunteers had been involved in the previous Forum Theatre study and consisted mainly of non-computer users, or those with very limited computer experience. As with the studies reported in previous chapters, volunteers were first telephoned by the author to organise a date and time of meeting. This was shortly followed by a letter confirming their involvement. Overall, studies consisted of six separate groups (of 2-4 people), each lasting approximately 90 minutes. Each session was divided into two interrelated stages:

Stage 1: Structured brainstorming

Participants were presented with a small set of coloured prompting cards illustrating the various interactive steps necessary to have a two-way conversation between a TV caller and an associated recipient (**Figure 8**). As part of this process, they were encouraged not only to describe verbally, but also to ‘sketch down’ (regardless of the artistic quality) any design ideas they thought relevant, using coloured pens and a paper tablecloth centrally positioned within the group. Ideas for the set-up procedure were originally based on a task analysis model of

Microsoft Messenger™. As one of many popular Internet instant messaging (IM) clients with video conferencing capabilities, this seemed a sensible starting point to explore how an equivalent 'signing in' procedure would work for the TV environment.

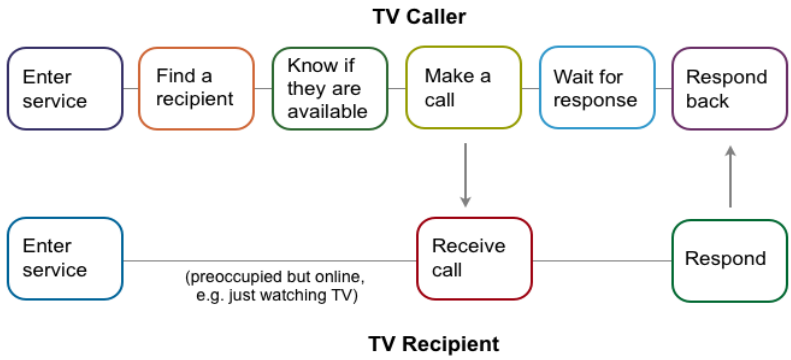

Figure 8: Diagram of the set-up procedure using the communication system

Stage 2: Paper prototyping

For the second part of the study, participants were given more concrete representations of what the communication system might look like via paper prototypes based on conventional metaphors for DITV. However, rather then present participants with screen shots or hand drawings of these examples, they undertook the physical task of assembling the interfaces themselves. In participatory design, the ability to change the physical artefact is an important way to engage with and to explore different points of view (Muller 2003). Working metaphorically from the basis of a 'blank canvas', each stage of the communication procedure presented users with different design possibilities from which they had to choose. Using low-fidelity cardboard and transparent cut-outs (originally designed on Microsoft PowerPoint) of various graphical components such as menus, labels and icons, participants were encouraged to select from and personalise the interface layouts (as illustrated in **Figure 9**). Once again, they were prompted to consider implementing such a system in their home environment more widely, while comparing these design concepts with earlier ideas they had generated themselves.

These paper cut-outs consisted of:

- **a contact list**: designed as a linear or hierarchical menu structure;
- **navigation bars**: including a mixture of text, pictorial, and coloured buttons;
- **graphical icons**: e.g. an open door, or telephone handset signifying an individual's availability;
- **contact methods**: designated pre-set numbers or on-screen dialling keypad;
- **dialogue boxes**: to indicate the connection status;
- **live video stream**: full or quarter screen;
- **incoming message (for the TV recipient)**: personalised or default.

Figure 9: Examples of the customised layouts using the various paper cut-outs, mounted on card with plastic transparent overlays.

6.3 Procedure

At the beginning of each session, participants were provided with an introduction to the study and were asked to give their informed consent. To assist in this process, they were presented with six separate PowerPoint slides (as paper handouts), depicting some of the basic aspects of the communication system. As previously discussed during the Forum Theatre study (see **Chapter 5**), these were used to remind participants of the technology in question. For example, they illustrated:

- the potential use of the system by different stakeholders (e.g. family, friends or medical professions);
- the feasibility of the system to be used on a global or local scale, and the types of multimedia that could be shared;
- the principle of video-conferencing, exemplifying the future possibility of a video camera built into an STB to equip users with the necessary 'communication' features (see **Figure 10**).

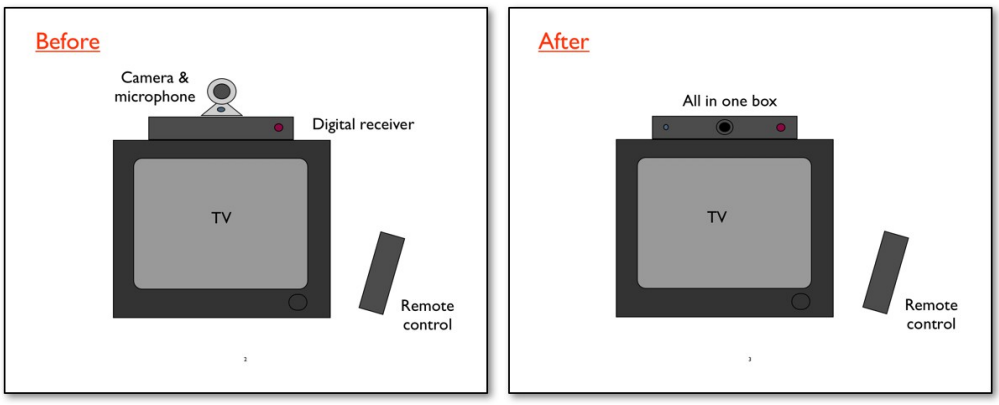

Figure 10: PowerPoint illustrations of a 'mock-up' communication system. (*Left*), a simplified example of the types of hardware components used for a two-way conversation; (*right*), future integration of components into an 'all in one' STB.

Following on from this, participants were asked in lay terms to describe how they would complete the first sub-task (that is 'enter the TV service'; see **Figure 8**). Once ideas had been extensively discussed, they were then given the next card in the communication sequence (gradually building up a row of cards on the table). To help explore the richness of ideas, for

each card presented, the author, as facilitator, would encourage participants to expand upon answers. For example, for ‘finding a recipient’ participants were encouraged not only to elaborate on who these people might be, but also what information would be needed about them, or how they might expect to find such information. Throughout this process, participants were asked to expand on answers by sketching and writing down ideas directly onto the paper tablecloth, where they could easily be viewed and amended by the rest of the group (**Figure 11**). To maximise clarity, they were encouraged to question or ask about anything they did not understand.

On completion of the task, the participants were then given a few minutes break, after which the same communication procedure was repeated, this time using a series of customised paper cut-outs pre-built by the author (**Figure 9**). For each step in the sequence, participants were presented with three or four design variations (starting with the screen background) in which they were asked to compare and contrast ideas. Through group deliberation they were then asked to eliminate those concepts they disliked and keep those they favoured. For each set of cut-outs presented, participants could then layer and rearrange these artefacts on top of previously chosen items, as part of the ‘pick and choose’ process. To complete the communication procedure, this was repeated from the perspective of both the TV caller and recipient. To summarise the session, each person was encouraged to compare ideas generated from the two separate activities, and given the opportunity to address any further questions or issues related to the study.

All sessions were recorded onto a digital dictaphone and photographs were taken during the beginning and end of each session so as not to interfere with the group interaction. In many cases the size of the room was too small to set-up video camera equipment properly. However, in hindsight a video would have been ideal to capture the visual activities. For analysis, (similar to the focus groups and one-to-one interviews from the first study), given the time taken to transcribe 15 hours of audio data, all studies were partially transcribed by hand in order to

identify underlying themes and to compare group-to-group differences and similarities in behaviour. These results were then written up using word processing software.

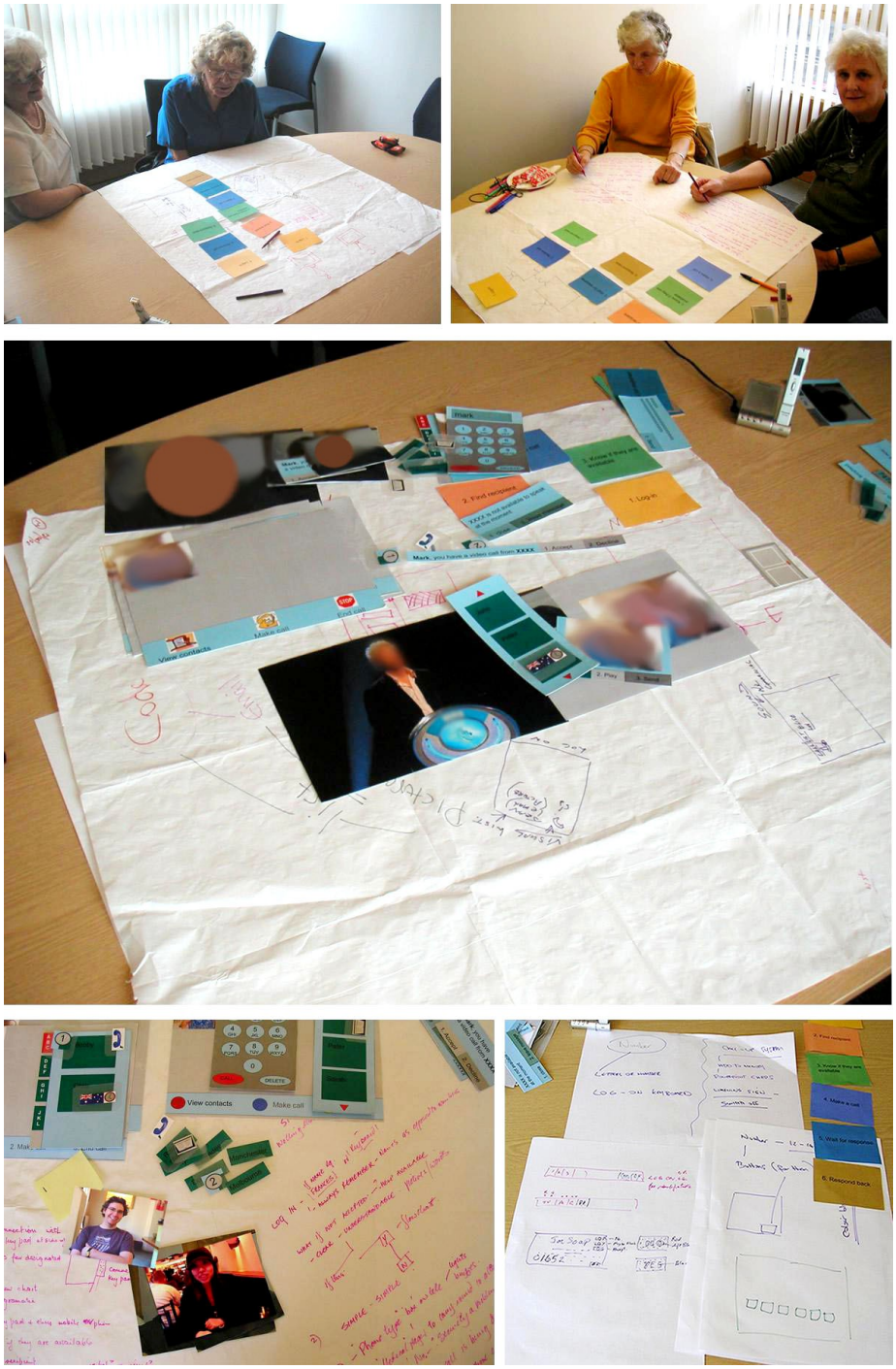

Figure 11: Examples of the paper prototyping and brainstorming sessions. (*Top*), photographs of participants' brainstorming ideas with the paper prompts; (*middle and bottom)*, examples of the paper cut-outs with brainstormed ideas that emerged at the end of the sessions.

6.4 Results

Both stages were successful in identifying a range of issues with regard to the design and use of the communication system. In a number of instances, these included ideas elaborated on through personal accounts and experiences with using related technology, at times envisaging how they (stereotypically) foresaw other people in their age group to interpret using the design concepts presented.

Overall, both the brainstorming and paper prototype sessions reconfirmed the need for design simplicity and a separation from complex applications, considered a hindrance in the adoption of new ICTs. As such, it was argued that the development of this system had a great opportunity to overcome a lot of prejudice in older people who deliberately separated themselves from using desktop computers. Overwhelmingly, many participants favoured a communication system related to the familiarity of associated interaction models and metaphors of conventional technologies to take the predicted 'fear' or 'stigma' out of using a system that was considered distinctly 'alien' and 'new'. Consequently, it was argued that this application should be built on knowledge associated with the familiarity of analogue television, more than any other system (despite a number of references made to the personal computer, e.g. see **Sections 6.4.2** and **6.4.8**).

From a technological perspective, concerns were voiced about young designers failing to appreciate the nervousness and apprehension many older participants, like themselves, felt at the challenge of building new skills into their existing 'repertoire'. Similar to the Forum Theatre, remarks were made about not knowing where information was being sent, reiterated by the problems of 'speaking into a vacuum of nothingness', and the complexity of using highly functional systems:

> *One of my problems with computers, I'm going to make mistakes, and then I can't undo what I've done and get back to where I was. Its kind of like a Rubik's cube, you know, you just make a bigger mess then ever.*

> *...for elderly people, and I include myself in this, I want the thing as simple as possible… something that I recognise, looks familiar, something I used in the past.*

6.4.1 Analogies to the telephone

Given the emphasis on user generated ideas, during the brainstorming sessions mental models of the system were heavily influenced by the capabilities and physical limitations of the telephone. Notably, this included being able to 'ring' the person they wanted to speak to on what was described as a 'call-up' system, by 'dialling' a sequence of numbers on a separate hand control, or more directly by selecting a dedicated pre-set button (i.e. one button per person). This modified remote control was perceived to operate like a mobile phone, which was argued, could be physically attached to the side of the television set (see **Appendix B**). Selecting an individual by their 'telly number' led to vague assumptions that in order to 'pull the person out of a memory bank', users would have to be quite selective in how many people's details they initially stored in the system, given the uncertainty of how many buttons could be designed on a remote control interface. Similar to a mobile phone, other options included 'printing' (i.e. typing) the name of the contact onto a handset display, in what was repeatedly referred to as the 'telephone pad'.

> *Aren't we entering an age when we have all got numbers and we might as well use that number… we dial up people on the phone, that's what goes to mind.*

Questions were also raised over the possibility of 'crossed lines' in terms of receiving interference from another call. The use of a digital phone book was quickly dismissed by one participant because he argued that he needed a magnifying glass to read the text in a paper-based telephone directory. Directly comparable to how a telephone works, in more extreme cases this included the assumption that an individual would first have to be contacted using a landline, to know if they were available, prior to 'tuning' (i.e. connecting) both television systems together:

> *You'd just phone them on an ordinary phone…'Are you available, I'm going to send a message through now.' You then key in the number, by then they are sitting by the telly watching… with your ordinary phone say 'I'm trying to contact you, I want to speak to you. I know you are not available', or 'can you phone me back when you are available?'*

To a similar extent, uncertainties were also raised over how the TV recipient would identify the 'caller', as many participants assumed there was no obvious way of knowing someone was 'contactable' prior to calling them directly. This included doubts whether a call would still be received if the system was turned off or on standby, while wider questions were raised over the feasibility of inviting a third party to participate via a 'designated number', and, as with a telephone, the outcome of two people with different systems pressing the same number (i.e. would they contact the same person) Given the possibilities of not wanting to receive a call, further options included leaving a voice message on a television answer-type machine, including automatic call back (similar to dialling 1-5-7-1[32]) or 'engagement' options if the person was not available. Ideas of a blinking icon or message box on the television screen, or alternatively a dedicated switch that could either light up on the remote control or on the front panel of the set-top box were all perceived as viable options for receiving an incoming call. In many of these cases, descriptions were brief and vague. However, regardless of the technical implementation, appropriate feedback was seen as a paramount feature in using this system, as one participant described:

> *I hate when I go to somebody's home and I press their doorbell and I can't hear anything. I don't know if they haven't heard, or the bell's not working, so I really do like, if I started something, initiated, I like to know that this is being looked at.*

6.4.2 Related computer usage

In addition to the telephone analogies, those with some computer experience made direct comparisons to PC-related applications, using terms such as *logging on, clicking on* and *keying*

32 A free telephone answering service supported by a number of telephone service providers in the UK.

in information. Currently learning Microsoft PowerPoint, one participant remarked on the use of separate slides (referred to as 'cards') to switch between 'different frequencies', that is separate camera, television and telephone modalities. Related comparisons were also made towards built-in help menus or email and MSN-type chat applications, with descriptions of how an organised list could appear at the bottom of the television screen either to indicate those contacts directly available, or to show who had previously called. Given that it was assumed that some kind of access code would be needed to contact a person directly, an email address was favoured. Being a visually orientated system, it was argued that this could include a symbol, icon or picture pertaining to an individual. 'Clicking' on this would then reveal an underlying name or list.

6.4.3 Working with the paper cut-outs

Within the paper prototyping stage, the visual examples encouraged open discussion and allowed participants to choose between the sets of design concepts presented. As a result, participants saw pros and cons in many of the design ideas, which were often favoured for very similar reasons. For example, comparison of the linear and hierarchical menu structures revealed both navigational styles were favoured for their perceived ease of use and design simplicity. For the linear menu, in being restricted to scrolling up and down an index of numbers, while for the hierarchical address book, in being able to separate out contacts into different alphabetical groups.

The observations also revealed participants would, at times, contradict themselves, particularly in instances when a design preference was less easy to identify. A good example relates to comparisons between the use of graphic and non-graphic (i.e. text-based) information. The use of text icons, such as 'available', or 'not available' to indicate if a person was 'online' (or not), was initially favoured as a more explicit means of representing screen content when compared with the ambiguity of graphical icons (which were criticised for being 'too busy'). However, as time progressed, these participants would often revert back to talking about the importance of a

'visual system', of using clear and concise graphics to improve screen legibility, particularly given the age-related loss of vision of older people. This level of agreement in the group, particularly with the author, reflected the 'overly' positive feedback received. However, the concurrence of an individual's thoughts with those of others can also be attributed to a tendency to conform to group norms (a known constraint of conducting focus group studies [see **Section 4.1**]). As a result, the author had to be quite explicit in asking individuals to reflect upon their own points of view.

Aimed at stimulating ideas, the paper cut-outs produced some limited variations on the ideas presented. Although not new to DITV, these included adapting the fast-text colour keys on the navigational bar by highlighting, flashing or sequentially numbering items to be selected. On three separate occasions (and by three separate groups), associations were made with the use of a traffic light sequence to determine when a contact was 'online' (e.g. green accept the call, red reject it), or to illustrate the process of making a call (amber, view contacts; green, make the call; red, end the call). A few individuals also modified the representation of the paper cut-outs, particularly the graphical icons to demonstrate how they could be combined in use. For example:

> *As soon as you click on, you want to speak to Sarah, OK the door would open. You then ring Sarah, you'd have the phone ringing, Sarah answers the phone, the phone stands up.*

Yet, despite this illustration, more commonly, ideas were limited to the prompts presented. These included very similar suggestions to the original graphical cut-outs, such as an expansion of the 'open door' metaphor to include an 'open window', or alternatively 'closed blind', or 'closed door' (if someone was not present). Other ideas were more ambiguous, including one participant's description of using a 'little man or woman' icon to indicate a secure site. When asked to explain why, she was unable to clarify further. At the same time, those participants with computer experience would revert to previous ideas generated during the earlier brainstorming

sessions, such as incorporating numbered PowerPoint slides into an address book, or, like instant messaging, displaying visual images or a contact list. Analogies were also drawn with using the telephone, underpinned by a misunderstanding of why a person could not be directly contacted, which again seemed to conflict with previous working knowledge of this device (see **Section 6.4.4**).

> *We kind of agreed when you come back to the email identity that because we are talking about a visual thing, it would be good if they had something else on it, a picture. I mean suppose you desperately wanted the doctor say, OK you go into 'D', but I think it would be extremely helpful if you could see right away on screen the stethoscope, whatever identifies that doctor you know.*

Strengths of using the paper cut-outs included their ability to stimulate discussions on the examples presented. A good illustration of this was the use of categories to group related contacts. This included the option to organise individuals by where they lived, i.e. 'by place', which was criticised for not being an intuitive means of searching for somebody, particularly those people who moved around a lot. Similarly, problems were also foreseen in searching by Christian name, as it was argued there might be *"half a dozen Johns in the system"*. This reconfirmed the need for a visual representation, such as an image or symbol next to the name of the person in question (again, strongly relating back to an instant message-type application, as previously reported in **Section 6.4.2**). Other suggestions included adding additional categories to the application, in what was described as 'itemising items'. This was seen as a useful means to speed up the search facility, by separating out contacts into groups of family, friends, professions or other related categories. In many instances, it was assumed that participants could customise these features themselves. However, when pressed on how they would do this, a considerable amount of doubt and speculation emerged. By contrast, one argument against customisation was that this could easily complicate the system, given, it was argued, the priority to understand additional features, such as an on-screen glossary or help menu.

6.4.4 Understanding the communication procedure

In having previously identified strong comparisons with the telephone, there were noticeable difficulties in determining the 'online' status, or presence of a person, prior to calling them directly. Comparable with the use of pre-set keys on a remote control, the option of displaying a default number allocated to each available contact was not easily understood. In individual cases, these assigned numbers were interpreted either as a preference list (assuming the person who was 'number one' was 'most available'), or an indication of those persons willing to have a group conversation (in what was described as a *"chat room-type thing"*). While the author re-emphasised that both parties would first have to enter the TV service (the equivalent of 'signing in' on a IM client), the uncertainty of knowing how the system would prioritise their availability (or indicate if someone was 'not available') led to the premise that switching on the camera was the only feasible means of determining who was directly present.

> *If two people are available, I don't see any way of knowing whether you should call one or the other, that's a personal choice isn't it.*

In many respects, this feedback is familiar to the analogous models previously identified in **Section 5.4.7** with regards to questions about the perceived functionality of a television system. However, the concept of assigning a number to alert each available contact was further complicated by their interchangeability (given those contacts available would alter depending on their online presence). Consequently, this automatic assignment of numbers by the system was seen to increase the likelihood of the user making a subsequent mistake. Like pre-set numbers on a telephone, reverting back to the original ideas in the brainstorming sessions raised questions about the possibility of allocating a permanent number on the handset to one per contact, although it was uncertain whether a single digit would be sufficient to 'dial through' to the person in question (compared to a more familiar 11 digit telephone number). Options of inputting text also included the equivalent of an on-screen dialling pad to type in a specific name or number, although it was reported as a cumbersome means to input information ('letter by letter').

6.4.5 Aspects of the video messaging

There was some reluctance, particularly amongst the older female participants, about being viewed on-screen, as they were self-conscious about being seen by other people on a television set. In **Section 5.4.1**, having previously identified the importance of establishing an appropriate social protocol, in terms of using a working system, a full screen video (assuming high resolution) was thought too intrusive, allowing other people to see something in the room they were not supposed to. Preferences were therefore drawn between 'condensing' the video screen as small as possible, in to what was described as a *"passport size image"*, or removing it completely (unaware that alignment to the camera was necessary to stay in focus during a two-way conversation). On the other hand, it was argued that the video size was a refinement in the design of the system, and therefore users should be given the choice to 'optimise it'. However, given variations in opinion, the size of the video was thought to be predetermined by the dimensions of the television display (not by the user). Further, it was acknowledged that being seen on-screen could provide additional assurance that the technology was still working correctly.

6.4.6 Receiving an incoming 'call'

Uncertainties were raised over the feasibility of receiving a call while watching a television programme. Would an on-screen dialogue box indicate the incoming caller (like the handset in **Section 6.4.1**, questioning if it would be 'physically attached' to the television), or would users respond by either touching the screen, or pressing a button on the remote control. A reoccurring theme, similar to using a telephone, there was a consensus that both parties would have to agree, providing 'visual' and 'non-visual' options to empower the TV recipient to choose whether to see the caller, or not. Suggestions included preferences for a separate 'ring tone', or 'noise signal', distinct and separate to the telephone. Within this process it was also thought that the choice to accept a call meant watching a television programme became irrelevant. Similar to the etiquette of turning off the television when a visitor came around, many participants thought keeping the current programme on would become an unnecessary distraction. Therefore, there

would be little interest in wanting to talk about programmes they could be simultaneously watching. As a result, it was assumed that the screen would automatically 'blank out' when a call had been accepted.

In terms of rejecting a call, it was also thought necessary to leave a polite, but brief message. In most cases a default message was considered sufficient, such as 'sorry, not available at the moment', or 'please phone back in half an hour'. No reason was deemed necessary, suggesting that if it was important enough that person could always 'call back'. In addition, options were expressed for holding or pausing the incoming call so that recipients could prepare themselves before they talked to the other person. Recognising the presence of others, the possibility to control the conversational process (or at least its initiation) was reflected by comments such as *"my face is like an open book"*, or *"I'm not good at lying"*.

In understanding how participants would negotiate this interaction, of the few ideas generated, again the traffic light concept was reapplied from the earlier brainstorming sessions to illustrate 'the states' of a recipient's availability (red, you do not want to speak to them; amber, you are getting ready; and green, you start speaking). However, by contrast, a few participants wanted the more direct approach of 'accept' or 'decline' to remove any additional complexity in use.

6.4.7 Beyond asynchronous communication

Not everyone wanted to answer a call while watching a programme, or stay online if the person they wished to contact was not available. Because of a dislike of leaving messages on telephone answering machines, not only was the TV system thought of as being intrusive (an issue originally identified in study 1), but was also seen as being too dominating, in demanding the call be answered straight away. As an alternative possibility, a separate button to find out if someone had left a message was recommended. Hence, in addition to the asynchronous form of communication, some participants liked the option of leaving visual messages, particularly as it was felt that many people were difficult to contact, or because they themselves may be

preoccupied at the time of receiving a call. In this regard, a messaging system was thought to be the best means of communication for many people. As such, a visual link (described as "*television with speech"*) was seen as being far superior to text-based messaging (i.e. email), which was criticised for not conveying the 'tone' of the message.

6.4.8 A return to privacy and security issues

Similar to the Forum Theatre studies (see **Section 5.4.1**), privacy concerns were again drawn from commercial advertisers and 'outside agencies' imposing themselves onto users' television sets. While some commercial advertising was thought a necessity to cut-down on the operational expense of using the system, user control was unsurprisingly paramount in deciding whether the system would be adopted if commercially available. Yet, despite some initial scepticism, in many instances volunteers indicated they would trust the system from 'mischief making', given this facility would not be used for high level banking. At the same time, in a more extreme case, having mentioned his son worked in financial security, one participant felt a minimum 12 digit password would be required for such a complex 'transitional' system (i.e. a system combining TV and telephone technologies). This was considered problematic as most people found it difficult to remember more than four digits:

> *Five years down the line the technology may not be there for it because the systems then start crossing over and you got to convert one system getting into another, this would be, you really are looking at sixteen figure numbers the time you get this sort of thing.*

Security access via a verifiable password was therefore considered, most commonly by using a familiar name. However, a few participants emphasised older people, like themselves, were more prone to forgetting this, commenting *"you forget things you think you will never forget"*. Therefore, when asked how they would expect to retrieve this forgotten information, more extreme measures were resorted to, such as 'sticking' the password on a keypad (i.e. remote control), on the 'telly' (television), or simply carrying it around with them, all of which, despite the best of intentions, were known to compromise the security of the system. By contrast,

options for alternative passwords were vague, again referring to email-type features such as a mother's maiden name or famous person from history, describing how it could be part letters, part numbers. These possibilities were not limited to computer experience, as it was also assumed that seeing the other person in question would provide assurance that the application was secure.

6.5 Conclusion and discussion

Many older people lack a wide knowledge of digital technology. This raises significant challenges for the types of research tools that should be used to bridge the gap between concept and reality, as shown when participants cited the following problems:

> *It's trying to visualise it, when you don't have the vision, and don't know the technology, it's very, very hard to say.*
>
> *Some people, especially those who have never had contact with computer technology, really can't quite encompass the idea of what to imagine.*

As well as the use of live performance, paper prototyping and brainstorming sessions proved to be strong communication tools to convey visually the possibilities of new DITV applications in both a believable and a recognised manner. They also provided further evidence on how older people expected to use a two-way communication application which was built on conceptual models of related technologies. In particular, despite initial preferences for the system to be built around the TV metaphor, strong parallels were drawn with the use of the telephone (mobile or corded), and also with the use of the computer (notably MSN-type applications) for some users with fragmented computer knowledge. This also included familiar mental models, such as the traffic light concept, strangely reminiscent to one volunteer's experience working on a low flight navigational system during the 1940s.

The results were therefore heavily biased towards what people were most commonly used to and most comfortable talking about. Consequently, compared to the Forum Theatre, these

studies helped ‘define’ the communication system. While the theatre helped to identify overall interests in this area, the brainstorming and paper prototyping sessions gathered much more specific information on how the system could, or should work. Unlike the larger groups for the theatrical sessions, the small, intimate groups in these studies meant participants had a much more active role. Overall the sessions were reported as being a fun activity. Part of the reason for this it is believed was the ‘playfulness’ of using the paper cut-outs and drawings, underlining the key point that no idea was fixed or concrete, and consequently there were no right or wrong answers to the activity.

The results strongly relate to Muller’s (1991) description of PICTIVE as an ‘informal and toy-like’ technique, strong in visual creativity. For, like PICTIVE, in this study there was an element of play through the manipulation of graphical artefacts. However, the success of this approach must also be attributed to the lack of biased responses prior to starting this study, in order to maximise participants’ ‘genuine’ input of ideas (without being overly influenced by the author’s). In this regard it was felt that the PowerPoint slides provided just enough detail to inform participants of the system, as well as keep the author’s contribution in the discussions to a minimum.

In terms of the drawing activity, as a method it had mixed results. Approximately half of the participants were reluctant to write or sketch anything, regardless of the author’s encouragement. Part of this problem was due to a perceived lack of drawing skills, in some cases further hindered by another member’s willingness to draw. These former individuals seemed far more comfortable discussing ideas in the group, letting another member take on the drawing role. As such, drawings were done individually, in relation to the ideas discussed in the group. Because of this it is difficult to say there was no shared ownership or collaborative involvement. As illustrated in **Appendix B**, at ‘face-value’ these drawings/sketches appear quite crude and simple. However, as a process or mechanism of interaction, the success of the method was to allow individuals to ‘talk through’ aspects of the system, such as its perceived

appearance or functionality. By itself this provided little information, but along with the audio recordings gave valuable clues into people's comprehension of the system. Therefore, rather than acting as a substitute to the open discussions, they can be seen to complement them.

In comparison, the paper prototypes facilitated a greater understanding of the communication system. As previously reported, a significant limitation of this part of the process was the fact that participants found it difficult to build or expand upon design ideas presented. Therefore, the paper cut-outs were far less successful at acting as a catalyst for specific designs. Rather, observations revealed volunteers were better at using the cut-outs as a basis for comparing ideas presented, in terms of identifying their strengths and weaknesses. Similar to the findings of Hornecker (2002), participants were found to be competent at synchronising actions, in rearranging cut-outs together and adopting meaning based on prior experience (in what she refers to as 'experience-orientation'). Consequently, at times there was a 'clash' between ideas originally envisaged from the brainstorming sessions and the tangible concepts presented in the paper prototypes.

The lack of new design ideas can also be associated with inexperience using related video conferencing technology and its associated etiquette, as well as a lack of understanding of technical capabilities, as answers were more indicative of 'older' forms of mediated communication. In this sense it was interesting to discover that despite modern day telephones being 'digital' systems, they were still thought of as conventional technologies, in which the software was restricted by the same rules governing the interaction procedures as outdated electrical or mechanical devices (e.g. by the user physically 'dialling' a number, or 'calling' the person in question to check their availability) - the conceptual understanding of which can be seen in reference to the earlier work of Docampo Rama (2001).

The studies also revealed a tendency for some volunteers, rather than identifying only their own preferences, to refer to what 'other' older people would want, both friends and generally older

people *per se*. Often these were 'stereotypical' perceptions of older people as resistant technology users. They were seen to have bad arthritis or poor hand-to-eye coordination and were altogether reluctant to use anything beyond a 'three button' control (demonstrating it's not just young people who create stereotypes). In this regard, it was assumed that many older people would be willing to sacrifice a lot of functionality for a system they could readily use. However, at this point it remains unclear the extent to which using the 'third person' was used as a means to reinforce participants' own ideals.

In relation to using the technology, options were raised for customising features (such as adding additional 'folders' or displaying video sizes) by using 'adaptable' or 'adaptive' measures. While in principle, this is a useful approach, research suggests that it is not foolproof (Bunt et al. 2004). In particular, there is evidence that customising features early in the learning of a new application is far more efficient than when the user has gained considerable experience (Bunt et al. 2004). To a large degree, this contradicted participants' expectations as they wanted to customise features when a user had acquired sufficient skills to do so. Similar to the remarks of using a 'modular system' in the Forum Theatre (see **Section 5.4.6**), there were vague assumptions that a customisable interface could help greatly. While the author does not dispute this, it is worth remembering that there was an over-emphasis on answers to short-term problems, namely by making the application work as simply as possible, with very little on how customised features would operate, given this terminology was used so imprecisely. In addition, it should also be recognised that stating that the system should be 'simply designed' is not only ambiguous, but from a practical perspective provides very little information to work from.

Overall, the findings from both the interactive theatre and paper prototyping sessions strengthen the argument for new metaphors and interaction models suitable for this age group, built on more familiar or identifiable concepts. This includes feedback from all three studies indicating a different direction in 'social TV' applications, and a move away from the focus (to date) on developing rich communication activities that facilitate interaction with the broadcast content.

Rather, it appears it is television as a familiar technology which is much more important than its broadcasting attributes *per se.*

By repeating the challenges of working with older adults, this study illustrates the true complexity of designing novel applications for people who provide an analogy of a hand-held device physically attached to the television, on which they expect to 'dial' the person they want to contact. Although in the process of designing such a system it could be argued that such individuals would recognise the limitations of their ideas, it is the bridging from the outset of what is unfamiliar and unknown with what is truly understood (i.e. compared to merely agreeing with the researcher) that will continue to remain such a challenge in early requirements gathering and associated ageing research.

7. Comparing four navigational approaches for interaction with a video messaging application

7.1 Introduction

Having identified a number of strengths and weaknesses in engaging with older adults in novel design solutions, for the next iterative step, a decision was made to explore a more empirical phase of evaluation. This was primarily done to determine the types of difficulties which might emerge in working with older adults within more traditional forms of observation, while gathering feedback towards the extent these individuals could subjectively assess their own levels of performance. In conjunction, this study also aimed to assess the author's own role as a facilitator/observer, and examine how this relates with participants' ability to independently (and hence successfully) complete a small set of tasks.

To aid in this process, in narrowing down ideas from the Forum Theatre and paper prototyping studies, a series of interactive prototypes were developed to explore potentially more intuitive navigational methods for searching and organising information on a 2D screen. From the range of feedback previously gathered, having established the importance of issues related to participants' conceptual understanding, acceptability and social usage associated with DITV applications, a decision was made to extend the *digital scrapbook* theme and the possibility of rich multimedia sharing via both synchronous and asynchronous communication (principally to stay in touch with family and friends). This prototype will serve as a 'case study' for examining the strengths and weaknesses of a more structured, empirical approach.

In particular, as navigation is a fundamental requisite for learning the structure of any application, the author decided to consider more visually creative ways of thinking about the display and interaction of on-screen content within a domestic context. This involved addressing the limitations of state of the art technologies currently employed in DITV systems (see

Chapter 3). Consequently, a prominent feature of these prototypes was the development of potentially more appropriate interaction methods in mapping between remote control and TV interfaces.

7. 2 Overview of the study

Using insights gained from the requirements gathering sessions, different navigational concepts were explored, each of which reflected participants original concerns over the design of technology built on more familiar aspects, as well as recognised approaches they could identify with from the physical world. To achieve this, the author developed a series of different 'experimental' layouts, graphically design to depict realistic and tangible objects to interact with (see **Figures 12-15**). Primarily to avoid disorientation due to 'snapping' - moving abruptly - from one screen item to another, the layouts explored *continuity of action* as a key navigational concept. Similar to dealing with the problem of 'getting lost' in hypertext systems (Kim and Hirtle 1995), the continuity concept intended to limit the disorientation caused from the snapping effect, which could prevent older users from navigating through the system. Evidence to pursuing this approach was supported by the complexity of the remote control usage as reported in **Section 5.4.5**, as well as more generally, interactive features strongly associated with the limited functionality of electro-mechanical systems in **Chapter 6**.

As a result of a lack of appropriate literature, much of the early screen ideas for incorporating 'continuity' into navigation were influenced by the visualisation work of Bederson et al. (2000), Card et al. (1991) and Fry (2004), as well as research specifically related on animated transitions (Gonzalez 1996). While these studies predominantly focused on the manipulation and retrieval of rich data sets for desktop applications, they were nevertheless seen as good 'benchmarks' to work from, in galvanising ideas for alternative navigational approaches.

As conventional interface models have thus far been designed using concepts drawn from the workplace, such as the desktop metaphor, and built around principles such as efficiency and

productivity (see **Section 1.2**), the interactive techniques applied in this study are focused upon engagement, ease of use, affordances and a form of navigational narrative. That is, given participants' understanding of more traditional forms of technology (e.g. the telephone), the prototypes took into account the generational differences of potential users by exploring more natural, real-world metaphors and visual cues to directly and visibly guide them through the tasks at hand, while at the same time trying to reduce the complexity of displaying multiple amounts of information all at once. As a control for comparison with these novel approaches, a fourth interface was built based upon the familiar navigational structures found on current digital interactive systems (see **Appendix D**).

At the same time, given the dual interface issues as identified in study 3, rather than focus solely on graphical content, these prototypes were all developed to be manipulated with a simplified remote control using six navigational buttons (see **Figure 16**). As identified in **Section 3.7**, given the acknowledged usability issues for older people with current handsets (such as memorising the location, sequence and density [i.e. size and number] of buttons, and switching between different corrective lenses for different viewing distances), the buttons were much larger than on standard controls, clearly grouped, and designed with appropriate force placement (e.g. by emitting a small 'click' when pressed).

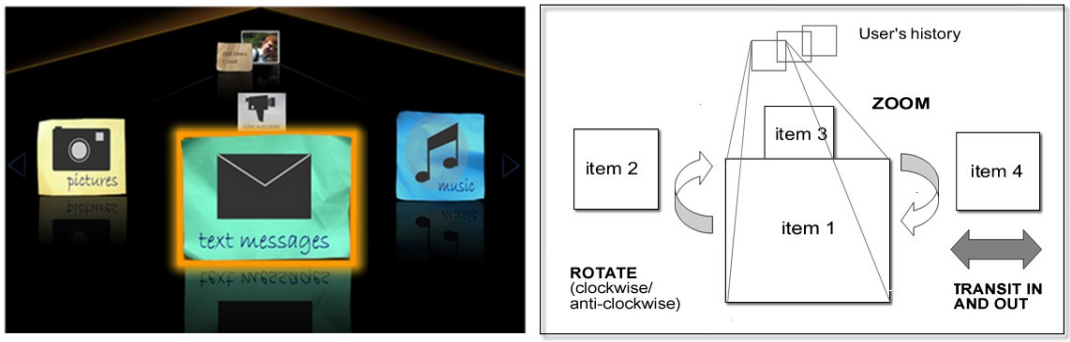

Figure 12: (*Left*), screen shot of the *Carousel* layout; (*right*), items can be selected by pressing the left and right navigational buttons to smoothly rotate around the carousel. Typically, once the item in the forefront of the screen is selected, it zooms to the back of the screen to form a continuation of the history list. The remaining layer then slowly transits towards the right of the screen and the next layer subsequently emerges to allow selection.

Figure 13: (*Left*), screen shot of the *Flipper* layout; (*right*), items are organised, in this case monthly, by separating them onto individual sheets of paper. To select a message, users flip over the paper by consecutively moving the left and right navigational buttons (thus, working through the 'pile' with cues as to their whereabouts within it). Users can also zoom in and out of the paper to select and watch a pre-recorded message.

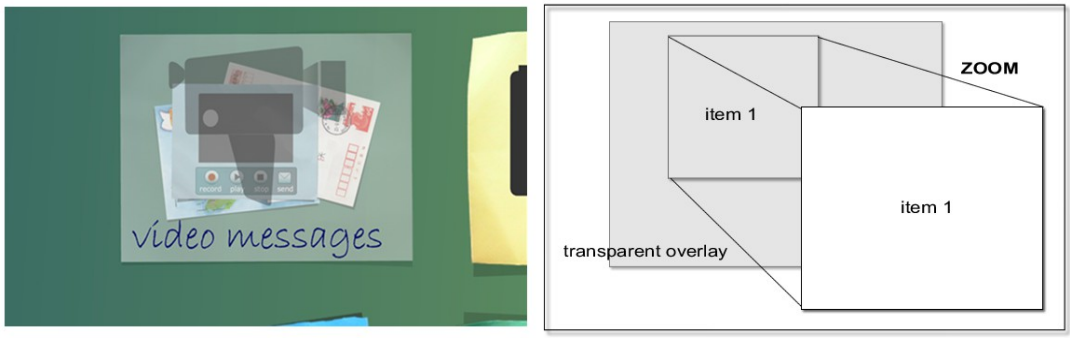

Figure 14: (*Left*), screen shot of the *Transparency* layout; (*right*), once a menu item like 'video messages' is chosen, the application automatically zooms onto the menu item, becomes semi-transparent and the subsequent layer is revealed. Users then have the options to zoom back, or to zoom in to reveal the underlying item.

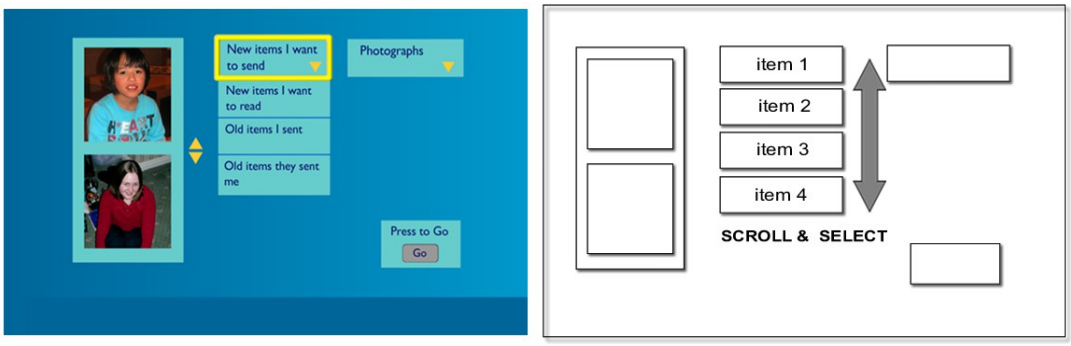

Figure 15: (*Left*), screen shot of the *Standard* DITV layout; (*right*), users can scroll up and down each item by pressing the up and down buttons. To select an item, they press the 'in' button. Users move across menus by pressing the left and right navigation buttons. Once an item is selected the screen 'snaps' to the next set of options.

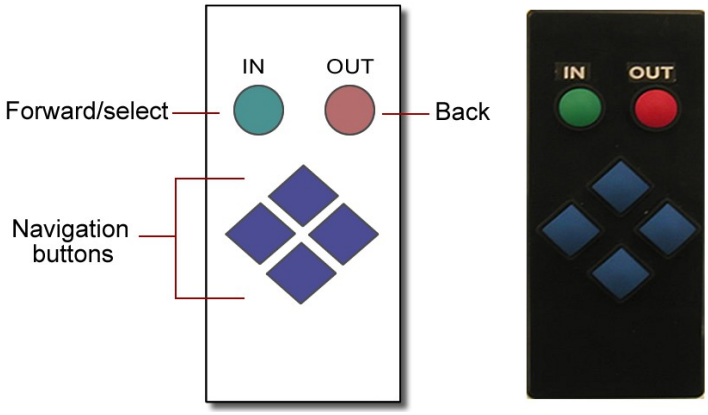

Figure 16: Illustration and image of the remote control handset

7.2.2 Software development

To replicate a realistic software environment, over a six month period a number of prototypes were iteratively developed in Adobe ActionScript 2 (AS2), in conjunction with Flash Media Server (FMS) for real-time video streaming (**Figure 17**). Examples of early prototypes can be seen in **Appendix C**. Earlier versions of Flash Player (5+), a standard for delivering web content, are now increasingly supported on a number of set-top box systems (Adobe Systems 2008). The use of FMS meant it was able to reside in a local host server (with support of Server-Side ActionScript [.asc files] stored in the local application directory) to provide a connection with the Flash player using the Real-Time Messaging Protocol (RTMP)[33]. Once connected, the Flash player could then evoke appropriate methods to capture and record audio and video data to the server, or playback previously recorded multimedia streams.

33 Designed for limited bandwidth availability, the Real Time Messaging Protocol (RTMP) has been specifically designed to maintain a persistent connection between the Flash player client and back-end server to enable real-time video and audio streaming (Lesser et al. 2005).

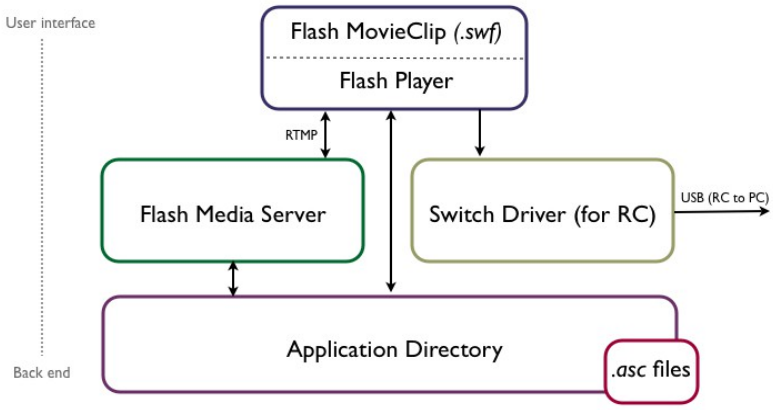

Figure 17: Diagram of the software architecture

For the evaluations, given practical problems of getting access to an appropriate STB software development kit, the prototypes were designed on a PC workstation, with real-time support from a Logitech Quickcam Pro 4000 web-camera for audio and video messaging. Given current advances in home multimedia and STB systems, it is expected that equivalent facilities will be available in the near future, deliverable over IP and other broadband and cable networks. The layouts were displayed on a 26" wide screen LCD television screen, and although the remote control was not fully functional for this study (given some technical difficulties in mapping between buttons and functions across the interfaces created), it was nevertheless physically connected to the PC via a switch driver to imitate the use of a working handset.

7.3 Procedure

Following a similar process of recruitment to study 3, 19 older people (7 males; average age 70 years, and 12 females; average age 71 years) were recruited locally, based on their involvement in one or more of the previous studies. This group consisted mainly of novice or non-computer users (apart from 4 participants who had moderate to good computer experience), ranging widely in their understanding and knowledge of digital television. As previously stated, as these prototypes were not fully functional, a 'Wizard of Oz' type approach[34] was used, in which

34 A popular method in HCI, it is used to evaluate a user's interaction by simulating aspects of a working

participants were asked to navigate through a real-time system. Initial pilot studies established that the number of tasks was rather overwhelming. Based on this feedback, aspects of the sessions were then amended before the main study was undertaken.

In more detail, each session was separated into three distinct stages:

- introduce participants to the navigational concepts;
- ask participants to complete a small set of on-screen tasks;
- present and gather feedback on four alternative input devices.

Firstly, after providing a verbal overview of the study and asking for informed consent, the author demonstrated four interactive examples (one per layout) of the different navigational styles. During this time, each participant was given the opportunity to practice moving the on-screen highlighter, and to select one or more graphical object, in order to view transitional effects mimicked using the prototype remote control. Given the lack of technological experience, participants proceeded to the next stage, only once they felt comfortable using the different navigational styles.

Presented on four different prototypes, the older adults were then asked to complete two tasks: i) record and send a new video message, and ii) find and replay an 'old' (previously recorded) video message. The first task involved finding and selecting the appropriate contact, which once complete required participants to navigate to the stage of being able to record the message, record the message itself, and then finally send it to the contact. Alternatively, for the task of viewing an old message, this again involved the process of finding and selecting the correct contact, after which to search for, and once found, play the correct message. In this instance the author pre-recorded a series of messages, which appeared within the prototypes. To support the instructions for each task, a prompting card with the image of the contact to be selected was

system. This is typically done by the designer (or equivalent) translating the input commands of the user, in order to observe their subsequent actions in behaviour.

provided. Once each task was completed, participants were then asked to return to the start screen. Following on from the completion of all tasks, a series of short open questions were asked in regard to using the different layouts, and more specifically interaction issues encountered. To minimise the potential for learning bias, the presentation order of the layouts was counterbalanced.

For the third and final stage, participants were presented with four alternative input devices to discuss in relation to the layouts used. These included a) a DITV keyboard, b) virtual keyboard displayed on a television monitor, c) remote control with touch pad and stylus, and d) remote control with additional alphanumerical buttons (similar to a mobile phone). Given the tasks involved using video messages, questions were raised surrounding the use of entering and annotating text-based information. This involved either being given a physical demonstration of the device (in the case of the keyboard) or on-screen PowerPoint presentation (for the other examples). During these discussions, they were encouraged to 'think outside the box' by considering other navigational possibilities not previously addressed.

Undertaken in the usability lab at the School of Computing, all sessions were recorded to video using a JVC mini-digital camcorder with a built-in microphone. This was carefully positioned at the back of the room to simultaneously capture both screen and remote control interaction (see **Figure 18**). At the end of each session, all video data was rendered into Apple QuickTime (.mov) using Final Cut Studio (a professional software video editing tool). For qualitative analysis, all videos were reviewed, both to identify specific, and more generalised patterns of behaviour amongst participants.

Given the sheer quantity of video collected (nearly 30 hours) rather than undertake the time-consuming and complex procedure of fully transcribing all the data 'frame by frame', detailed descriptive notes, including excerpts of videos were partly transcribed by hand, to illustrate and reflect on relevant examples of different forms of interaction. As a result, it is important to

emphasise that the author was not looking to analyse more in-depth spatial or linguistic behaviour. Supported by the argument that non-technical solutions can be as effective as specialised qualitative software packages in video analysis (Spiers 2004), an examination of data was done by hand, and edited using a simple word processing program.

7.4 Results

Overall, users were intrigued by, and engaged positively with the prototypes used. However, in some cases, inexperienced participants were apprehensive and uncertain in making screen selections, and asked for more confirmation and reassurance about actions they were about to, or had just undertaken (reflected in comments like *"I would have done better with written instructions"*). In such cases, it became important for the facilitator to motivate participants, subtly encouraging them to explore alternative directions, while re-emphasising the acceptability of errors in the study. In other instances, users felt very comfortable in experimenting with the different layouts. At times, hesitancy was countered with an expectation that an understanding of the different layouts would be acquired through practice. However, it is difficult to assess the extent to which these older users would persist with some of the more difficult aspects of the applications should they be in a more familiar setting, such as their home environment.

In terms of prototype preferences, participants favoured the carousel design (see **Figure 12**), commenting upon its simplicity, ease of use, and its ability to guide them through the various steps at hand. However, participants were also largely positive about *all* the layouts shown, despite the observations finding noticeable differences between what users *said* they preferred, in comparison to what they could *actually* do. In this sense, a lack of differentiation to the navigational styles related to derogatory terms used to express their own inabilities to use computer systems (e.g. by suggesting *"the layouts were good for idiots like me"*).

Figure 18: Participants with remote control interacting with the different layouts, presented on a 26" widescreen television display.

As previously discussed in **Section 2.4**, these sessions also found noticeable weaknesses in using the think aloud protocol (TAP). Given the cognitive demands of completing tasks for the first time in a controlled environment, getting users to describe their actions became counter-productive to the study. Speaking aloud undoubtedly interfered with their accuracy to complete tasks. Subsequently, most participants simply stopped describing what they were doing. Further, in recalling the different prototypes at the end of each session, users commonly forgot which layout was which, and needed visual prompting to remind them. In terms of constructive feedback, all prototypes were praised for their ease of use compared to more conventional computer systems. In particular, they tended to be far more critical of themselves for not understanding aspects of the layouts, rather than as a result of poor design. While despite emphasising that these tasks were not a 'test on the individual', a few participants were self-conscious of how they performed in comparison to the other volunteers. Furthermore, given that only 8 out of the 19 participants completed *all* the tasks within the time allocated, it was decided to avoid a more detailed statistical analysis from the counterbalanced layouts[35].

35 As a minimum requirement all participants completed one task.

In more detail, from the evaluations, a breakdown of the main themes is described in the following sub-sections.

7.4.1 The remote control

The handset was rated positively for being big and simple to use. Participants commented that the keys were easily distinguishable, particularly in comparison to more standard remote controls. In one case it was directly compared to a mobile crane control in its shape, design and functionality, while another participant noted (positively) that it had the simplicity of something a young child could use.

Some mapping issues were observed in relation to the different on screen layouts, particularly as the learning and unlearning of each prototype further complicated the direct manipulation of screen objects. The ambiguity of the 'in' and 'out' buttons (referred to as the 'positive' and 'negative'), and multi-functionality of the 'in' button, in comparison to the 'out' button (which singularly operated navigation), also caused some confusion. As one participant commented:

> *Every fibre of my being wants to press the out button, because it's going out… you're actually in the place, you're in the recording studio as it were, so to send the message you would be sending it out, or is that stupid?*

In relation to the notorious difficulties associated with 'traditional' handsets for older people, such as unclear labels, insufficient tactile feedback and the poor position and size of buttons, it is important to stress the difficulties of simplifying the remote control, and getting it right first time. As Carmichael (1999) notes, while less buttons may reduce memory demands of finding functions on the handset, minimising the control can increase the workload when attempting to match more functions to less buttons.

7.4.2 Video messaging

Given the novelty of video messaging for many within the user group, some participants were

somewhat reluctant to see themselves for the first time on screen. Noticeable problems with the four button video controls (record, play, stop and send) included a tendency for participants to repetitively press buttons to stop functions, highlight (but not select) items, and more generally, forget appropriate mappings, even after correct button sequences were made. For example, one of the misinterpretations of button presses was based upon the assumption that highlighting alone automatically activated the selected object. Additionally, the sequence of buttons (ordered as record, play, stop and send) and the labelling of the 'play' button, rather than 'replay', seemed to cause some navigational difficulties, as this involved skipping across buttons, i.e. navigating from record to stop to make an appropriate selection. This was further hindered by a lack of 'visual feedback', particularly in instances when users had wrongly assumed a button had been pressed. A good example of the need for visual confirmation was seen in the uncertainty of recording a video message, and whether this message was being recorded, or not.

The findings also revealed an immediate expectation by some individuals that they could speak to record a message, without pressing any buttons or navigating to any specific point on screen. Although this may be accountable to initial nervousness in using the system, it does demonstrate another challenge presented by older users unfamiliar with even the basic concepts of video messaging. Similar analogies were also made in the use of more conventional technologies, with parallels to a video cassette running inside the system (to stop recording a message). Observations revealed intriguing patterns of behaviour where, for example, one participant would press play before the record button to create a new message. When asked why he did this, he explained that this is how he would record something on this stereo at home (pressing 'play' and 'record'). Beyond indicating the ability to draw on apparently related mental models from previous experience, such variable differences in the ways technology can be perceived to work by older generations was well summarised by the following participant remark:

> *I was fourteen when I left school, and technology for me was when I learned how to use a pencil sharpener.*

Furthermore, these examples highlight how older users, within unfamiliar situations, can associate seemingly different design concepts as the 'default' metaphor. As such, it is important that these influences are understood within the context of attaining more usable digital systems.

7.4.3 On screen navigation

The study found noticeable differences between the new prototypes and more conventional layouts. To illustrate, the following sections present examples from the *Standard*, *Flipper*, *Carousel* and *Transparency* interface presentations:

7.4.3.1 Standard DITV version

Firstly, it appeared that the more traditional linear drop-down boxes and menu lists on the *Standard* interface proved far more difficult to grasp as, unlike the other layouts, information was largely concealed from view. For example, it was not obvious to many of the participants that they had to scroll down through menu items without some initial prompting from the facilitator. Few people felt that the directional arrow icons actually provided any assistance as to how a text box should be opened, particularly given mapping problems of opening drop-down menus by pressing 'in' (instead of 'down'). Through practice, once they became familiar with the navigational concept, the majority of participants understood the process of vertically navigating through drop-down text boxes. This however was noticeably different to the computer users, who had the ability to draw from first hand experience in using linear menu sequences and scroll bars within standard desktop displays.

As a result, participants could not always find information, such as a specific contact (i.e. like in an address book). Common assumptions were often made that, when a contact was not directly visible to view, they would be available, or stored on a separate drop-down menu with the heading of *photographs* (as each contact was visually represented as an image of that person, they were mistakenly thought of as a 'photograph'). However, attempts to select from this drop-down menu box only fuelled further problems over additional selection choices, as a menu box

could be highlighted but not opened if a previous menu choice had been incorrectly made. A lack of on screen feedback further limited users' capabilities to recognise relatively small screen changes, such as a change in the menu heading of an item selected. Confusion as to why drop-down menus could not be accessed, only led to additional hesitancy and anxiety. This also led to questions over the availability of a search facility.

In addition, there was a strong tendency for some participants to select the 'press to go' (on screen) button (sometimes referred to as the 'go' button), particularly when it was assumed no relevant information was explicitly available to view. However, this supposed shortcut option was designed only to take them to the next screen in the application, once all appropriate menu selections on that page had been made. Use of the 'press to go' button also raised questions over an equivalent 'go' button function on the remote control handset. The graphical button's position on screen (bottom right) meant users had to navigate across additional menu boxes to highlight it. However, few people seemed to identify the relevance of selecting from a menu box first. This again seemed to stem from participants' uncertainty, based on the menu headings provided, that these boxes held any relevant information. As a consequence of these issues, nobody was able to complete the first task with the *Standard* version without some kind of help or prompting from the facilitator.

7.4.3.2 Flipper, carousel and transparency versions

In contrast to the standard interface, layouts that demonstrated aspects of continuity appear to have noticeable strengths in aiding navigation. These included the use of a 3D graphical history in the *Carousel* that perceptually illustrated each menu item selected, creating a 3D trail across the top centre of the screen. However, unlike the navigation techniques of static breadcrumbs on web pages, this was done by applying animated transitions, designed both to allow the user to trace the movement of the menu item selected, and also to follow the item's transition out of the screen when the user wanted to return back to a previous menu page.

The 3D motion of the *Carousel* layout was rated highly due to its fluidity of movement in which information was sequentially presented (with related information still visible). Suggestions included the availability of additional search facilities in the navigational line to find, for example, when a previous message was sent. However, given the cognitive demands to complete tasks, it must be stressed that not all users were overly aware of this feature. Therefore, there are likely to be variations on the design of this transition, such as the inclusion of auditory effects, which may better draw attention to the function, beyond further practice with the system.

Furthermore, in relation to these known issues, additional patterns of behaviour were identified. In more extreme cases, such issues included a misunderstanding of the carousel concept, with attempts to persistently navigate back and forth across the same menu item, rather than rotate in one direction to shift the focus on the menu item highlighted. More generally, this included:

- pressing the ‘up’ key to select the menu item at the back of the carousel, as well as by default, the ‘in’ key to select the first menu item highlighted on screen;
- an expectation to orientate in the opposite direction applied (e.g. turn left to rotate the carousel anti-clockwise, rather than clockwise as designed). Overall, highlighting the differences in behaviour that can be caused by the ambiguous mapping of navigational structures;
- the ability to speed up the movement of the carousel, particularly in returning back to previous screens. Minor criticism was raised over the slowness of this approach, and suggestions included the ability to hold down the ‘out’ key to speed up transitions, with ideas from some computer users of an equivalent ‘home button’ as found on a standard web browser.

In addition to the Carousel, other transitional aspects such as the turning over and zooming in and out of information within the *Flipper* version both seemed engaging and successful ideas.

The virtual physicality of objects has been thought to be an important property in successful web search strategies for older people (Curzon et al. 2005), while (on a desktop environment tested with educated and relatively young adults) there is some evidence to suggest that animation helps to build up the spatial mapping of information on a 2D screen (Bederson and Boltman 1999). As an extension, the paper-based metaphor, displayed with many physical characteristics of 'real paper', was found to be a powerful navigational concept. Given the limited 'real estate' of the DITV interface, the option to flip over a graphical object onto its reverse side to reveal a related layer of information, affords a rational means of linking between menu items, and limiting clutter on screen.

Based on user feedback, response time to the animated graphics showed signs of successfully aiding navigation, particularly as the transitions used enabled very visible changes to an object's state. Comments indicated that with the *Flipper* version, screen changes were clear and menu choices apparent. For example, users quickly understood the idea of sorting through video messages, which were attached to graphical objects resembling sheets of paper (see **Figure 13**). Organised into a pile, each sheet displayed a group of messages for a particular month. By applying a simple navigational sequence (i.e. 'left' to flip over a sheet of paper clockwise, 'right' to flip it back, 'in' to zoom in on a video message highlighted, and 'out' to zoom out), users where able to search within layers and find a specific video message, unaided, and with relative ease. Similarly, options of highlighting and selecting to 'play' and 'stop' a video message seemed easily understood. Given the lack of on-screen instructions, there were variations to the navigational approaches, noticeably the difference between pressing the horizontal 'left' and 'right' buttons to flick through a group of objects, compared to the vertical 'up' and 'down' buttons, which for more participants seemed more appropriate given the positioning of paper objects in the arranged pile. In each case, without the use of more explicit screen prompts, some degree of flexibility would be favoured to aid navigation given the variations in conceptual models.

Praised for being logically sequenced and visually clearer, unlike the *Standard* version, this approach demonstrated that the older volunteers were far less perplexed when information requested was initially hidden from view. Rather, they were capable of independently finding information, provided familiar navigational concepts were applied. Consequently, very few errors were made. Those observed related less to the use of animation, than to inappropriate mapping and menu selections. These errors included:

- initially selecting the wrong contact, either by default because they had selected the first person highlighted, or because they misunderstood the purpose of the highlighter;
- inappropriate selection of menu items (see the next section);
- as previously described in the study, difficulties distinguishing functionality between the 'in' and 'out' buttons on the remote control handset (see **Section 7.4.1**).

Alternatively, visually similar in the design to the *Flipper*, the use of semi transparent overlays (in the *Transparency* version) caused more difficulties. While they were designed to illustrate a linkage between layers, overall the overlays resulted in more unnecessary distraction than help. While approximately half of the participants seemed to readily grasp the navigational concept, for others this caused them to assume they could retrieve un-selectable menu items behind the transparency layer, repetitively pressing buttons to activate these items, despite nothing being highlighted on-screen. Reduced legibility (due to interference from the background) also caused participants to try to switch attention, by repositioning themselves nearer, or, in some cases directly in front of the screen to read the text-based information (similar to reading through the screen). This noticeably generated more difficulties for those people with low vision (see **Figure 19**), a problem that has been identified in previous research studies (Rice and Fels 2004). It is possible that altering the level of transparency and/or transformation may alleviate these difficulties, although it may also be that the overlay approach itself is not helpful for older adults. Such issues warrant further investigation.

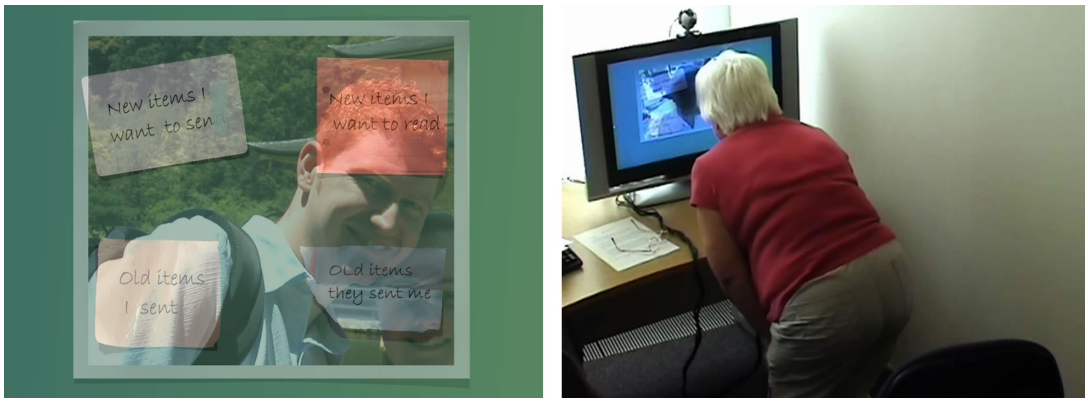

Figure 19: Examples of the transparency effect. (*Left*), displaying additional menu options underneath the picture of the 'contact' to whom they refer; (*right*), a participant close-up to screen attempting to read the text from the transparency layout.

7.4.4 Menu options and terminology

Given the diversity of older users, particularly their inexperience with traditional forms of digital technology, this research also identified problems when creating descriptive labels for menu items without any detailed explanation. Within the alternative layouts, despite limiting the display of menu items to four at any one time, inappropriate screen selections were still made. In such cases, part of the problem seems to relate less to the legibility or aesthetic quality of the graphical items, and more to differences in what multimedia terms can mean to older (particularly elderly) people, in comparison to younger 'techno savvy' individuals. To illustrate, initial attempts were made to choose 'pictures' instead of 'video messages' (to send a video message), as it was assumed the recipient would perceive seeing the incoming message like a picture. In other instances, 'pictures' was also thought of as an abbreviation for the term 'motion pictures', and its association with moving images.

Furthermore, in the task of sending a new message, the displayed image of a selected contact, surrounded by a small set of additional menu options on screen (e.g. to indicate items; to send, previously sent, or received from that individual), led to questions of whether that person was 'speaking to them' and therefore sending them a new message, or visa versa. While a relatively minor issue, such expected paths of interaction further illustrate the need for very explicit and

well thought out design, not only to increase the ease of understanding, but also take into account the variability of users' knowledge of the tasks (and metaphors) at hand.

7.4.5 Alternative input devices

To round up the study, questions were raised over the feasibility of using alternative input devices, given, for example, the possibility to enter and annotate text-based information in the video messaging tasks. To reiterate, these devices included a) a DITV keyboard, b) virtual keyboard displayed on a television monitor, c) remote control with touch pad and stylus, and d) remote control with additional alphanumerical buttons.

Responses were mixed, with no device gaining majority appeal. However, rather than resolve this issue, discussions reiterated the problems of asking older people to appropriately visualise uses of technology, beyond those that they are already familiar with. To illustrate, while many participants recognised using a remote control and/or keyboard, they were far more uncertain over the feasibility to input text on screen using a separate input device. Despite expressing difficulties in using mobile and computer technologies, assumptions were still made that regardless of the actual input control, they would expect to adjust to its use with relative ease. Associated learning models of digital systems were also found comparable to more old-fashioned electronic devices, as summarised below:

> *I've just bought a new vacuum cleaner, and I mean, it's just not quite the same, but within a day or two I will have got the hang of it, you know, its just a different system for setting it up.*

On a personal level, preferences for input devices included anything that was small, unobtrusive and easy to use. However, more specific choices were also given, such as the use of a simplified digital TV keyboard, as some people acknowledged having touch typing skills, typically acquired through experiences in using word processors or typewriters, or because it was thought a keyboard was the quickest and most legible way of reading and inputting text on screen.

Criticism included its lack of association with home viewing, and more specifically affiliation with computer use, with assumptions made that it might frighten and intimidate a lot of older people. Contrary to what others had said, the keyboard was also interpreted as an 'unsuitable object', an 'impediment in interaction', and one of the reasons older people did not use modern technology (i.e. because they could not type).

Alternatively (although not very practical), a virtual keyboard operated by a remote control was seen as better for older people with sight problems, to scroll across graphical keys at the bottom of the screen, while touch-screen interaction with a stylus, although disadvantaged by the small physical space of the display, was identified as a more personal and familiar form of writing, particularly its association with handwriting. In relation, little attention was paid to the alphanumerical remote control, particularly as some participants expressed difficulties, or lacked experience in text messaging. However, an alternative approach suggested was to incorporate the functional controls on the prototype handset within a standard keyboard. Although the use of predictive text was not explicitly addressed here, its potential benefit for some older adults means it may be worth pursuing in future research.

7.5 Conclusion and discussion

Overall, this study has highlighted a number of key findings from the prototype evaluations. These include, on the one hand, assessing the levels of engagement and understanding of the prototypes developed, while on the other, through the process of eliciting feedback from older adults, determining how successful individuals can accurately critique what they have experienced.

Within user-based evaluations, the conflicting roles of the researcher, both as a neutral observer and helpful facilitator are known to draw out bias in user responses (e.g. see Dumas 2003). Nevertheless, despite this, there is little directional guidance when trying to balance out the amount of prompting needed to encourage older volunteers to persist within related tasks,

compared to, in effect, leaving them to their own devices. As a result, this study does highlight a number of challenges for those people who will expect support during the initial set of problems encountered, particularly in using the system for the first time. More so, recognising that these issues are not applicable to all older adults, any intervention is likely to create strong debate, in weighing up the pros and cons of using a skilled and experienced facilitator to encourage involvement, without explicitly demonstrating what to do. As such, the fine division between allowing someone to 'give up' early in the task due to low motivation or confidence, compared to persisting and potentially overcoming barriers in related interaction, is likely to have a high impact on the amount, type and richness of qualitative data acquired.

Furthermore, a key constraint identified from this study has been the problem of directly asking participants to recall what they had done at the end of a session, in order to draw out comparisons between the layouts used. Subjectively, many participants were far less critical of the layouts after completing, compared to performing tasks. In this instance, rather than wait to get feedback after the completion of all layouts, it may have been much more beneficial to do this at the end of each task. At the same time, despite the use of visual prompts to facilitate further discussions on the types of input approaches applicable to this user group, disappointingly they failed to trigger more significant results. This was compounded by individuals becoming fixated on highlighting the difficulties they (rightly or wrongly) envisaged other older people would have in using the controls.

In terms of reviewing the types of prototypes used, the preliminary evaluations have found that the use of 'continuity' as a navigational concept potentially offers more intuitive and insightful approaches for people unfamiliar with associated systems. For example, older participants positively praised the use of this concept in aiding 'clear and concise' navigation, and 'satisfying the achievement of goals more easily'. Evidence further supported by the 3D navigational trail of the *Carousel*, where observations identified it helped confirm the placement of navigational steps taken by users, or the *Flipper* version, which was praised for its natural

fluidity of movement.

On-screen clarification must also take into account the very graphical design of interface objects developed to resemble their physical counterparts (aided by the use of a high resolution television display). As such, these findings indicate that navigational techniques that can mimic aspects of real world artefacts, in a manner individuals can quickly relate to, suggest an interesting avenue of interaction within DITV design. However, support for more successful navigational strategies must also be attributed to the design of a simplified remote control, which received high praise from older users, despite its rather early stage of development. The success of the resultant system is therefore dependent upon appropriate research strategies, which can take into account the value of both an appropriate input device and on-screen interaction.

By contrast, the study found a number of weaknesses in the design of more conventional layouts, which have strongly drawn ideas from desktop metaphors, particularly in their concealment of information using drop-down and scroll menus. In distinguishing between design differences, reasons for difficulties encountered were not always understood (e.g. *"the digital television layout seems clumsy somehow, and odd compared to others"*). At the same time, criticism was raised over the ease of use of the *Transparency* concept, in the misinterpretation of how to request information behind the overlaid image. However, given that none of the prototypes were fully functional applications, it is important to recognise that this limited the number of possible screen errors made. Clearly, with a fully working system, it is highly likely that many of the older people would have had more difficulties rectifying navigational mistakes, especially in the *Standard* version. Such results are open to further investigation.

8: Exploring the efficacy of animated transitions for a DITV environment

8.1 Introduction

Within hypermedia systems, there are many navigational cues to help users reach set goals, such as site maps, collaborative filter mechanisms, breadcrumb trails and associated bookmark features (Sutcliffe 2003). However, despite evidence that a 'look ahead' approach may be beneficial to groups of older people in helping them to determine their progression within TV-related tasks (Carmichael 1999), no equivalent known features are currently deployed in DITV services. Extending previous findings, the research presented in this chapter reports on the development of a second iteration of prototypes that aimed to investigate the use of 'continuity', incorporating animated transitions and pseudo real world objects to determine their effectiveness in aiding the completion of a small set of multimedia tasks. Having previously identified the constraints and inherent difficulties for older adults using essentially 'static' approaches that conceal information by using scroll and/or drop-down menu boxes, compared to more imaginative means of dynamically manipulating graphical objects using associated transitional effects, exploratory navigational methods were further pursued.

Once again, these issues were set within the overarching interest of trying to engage with, and better ascertain constructive feedback from older people during a more detailed, task element evaluation phase. Iteratively building upon the results from study 4, this included trying to overcome some of the problems previously identified through the user-based observations. Namely, the complexity of getting individuals to persevere within tasks when surmountable barriers in understanding were encountered. Applying some of the successes of the paper prototyping exercise in **Chapter 6**, specifically the playfulness of manipulating groups of physical objects, a small number of photographs were informally introduced to participants to precede the on-screen tasks. In this instance, the familiarity of physically organising a small set of images was considered a good ice breaker. To accommodate for the problems of recalling

what had been undertaken, all participants were asked a series of short questions to summarise their experience after each task had been completed.

For the prototypes developed, much of the literature relevant to this issue relates to virtual environments (VEs) and animated interfaces, which is potentially informative, but suffers from two constraining factors. Firstly, most studies are centred upon desktop applications to support work-orientated, information retrieval activities. Secondly, users tested tend to be young, well educated, and with relatively high levels of computer experience. Consequently, it can be argued that few studies have accommodated for the diverse variance of spatial abilities, and associated skills, within the wider population. This requires an understanding of the processing of visual information (Velez et al. 2005). This is particularly important given spatial aptitude can strongly impact on the performance of user interface comprehension (Cockburn 2004).

Of the limited studies investigating the effects of animated transitions, apart from research identifying improvements in task performance in animated (as opposed to static) icons (e.g. Bodner and MacKenzie 1997), Gonzalez (1996) explored how animation (as an interactive concept) can assist in the process of decision making. Her findings indicate that users were more accurate with tasks that employed gradual animated effects (in comparison to 'abrupt' transitions). However, she stresses the importance of other physical properties, such as image realism, level of interactivity and task domain. By contrast, exploring a family tree activity, Bederson and Boltman (1999) reported that the use of animation had a positive effect on users' understanding of the spatial positioning of family members in a linear structure, although they noted no improvements in the performance times when navigating through the information space, which they attribute to the type of task, animation speed and possibly sample size used. More recently, Bladh et al. (2005) used a 3D tree map design to implement transitional effects in order to demonstrate the relationship between associated file directories. Empirical results suggested that, compared to participants of the non-animated group that followed a designated route, the use of animation meant volunteers were more likely to take shortcuts, subsequently

finding it more difficult to recall previous steps taken.

8.2 Overview of the study

The present study examined the ability of a group of older users to navigate and organise small sets of multimedia using different forms of animated interfaces. More specifically, the research aimed to investigate the extent that different forms of animation can be used to aid social application areas for older adults, with limited technological experience. In total, three layouts were designed, varying in the types of animation and screen graphics used. These layouts consisted of two types of transitional effects:

1. animation to directly manipulate screen objects, which (once selected) would demonstrate a visual change had occurred; and
2. animation to navigate between sets of 'physical' objects along predefined viewpoints, in order to create the illusion of moving through a virtual, 'tangible' space.

In more detail, it was hypothesised that a) users would make less errors with the animated layouts; and b) building on the outcomes of study 4, become more disoriented by the deployment of a 'snapping' approach.

In order to test this hypothesis, a variety of animation techniques were developed using an array of transitional effects, such as sliding, rotating and zooming in, and out of screen objects. This extends the previous study by incorporating animation to control movement along predefined viewpoints. This is achieved by fixing the position, orientation and speed of the animation, and by changing the lighting intensity to create a compelling and perceptually realistic 3D environment (see **Figure 20**).

In further developing the 'real world' metaphor concept, the study drew upon the design of virtual environments (VE), in what Glencross et al. (2006) describe as *"being physically within*

a synthetically generated space" (p. 6), by employing variations in the use of hi-fidelity graphics, multi-modality cues, and input devices to track movement within real-time interaction. In particular, the study was influenced by how immersive VE environments are navigated through as opposed to environments within the physical world, drawing upon recommendations for the deployment of familiar and memorable landmarks to aid in navigational guidance (Vinson 1999). However, it should be noted that, for the desktop computer, while the advantages of 3D interfaces is still highly debatable (Cockburn and McKenzie 2002), studies by Sayers (2004) and Sjölinder et al. (2005) with older people illustrate the potential of using 3D navigation, despite finding differences in task performance times to younger adults.

In building upon these findings, the aim of this research was to adapt previously successful features from study 4. This included the design of the 3D graphical history in the *Carousel* layout that perceptually illustrated the sequence of steps previously selected. Variations in the navigational trail meant items were deliberately separated into the top left or right corners of the screen to distinguish their selection. For consistency, each time a user moved back a step, the previous object selected would automatically fade out to its original position, with the aim to help sustain user's orientation within the information space. This is demonstrated further in **Figures 21-23**, while **Table 5** summarises the differences in the design layouts used.

Interface	Description
Abstract continuity	This interface consisted of very simple, two-dimensional shaped objects, composed over a black background (see **Figure 21**). All graphical objects were displayed in separate monochrome colours with Gill Sans font. Similar to the *Carousel* layout in the previous study, the use of animation included the elliptical carousel design to navigate around menu items, as well as a sliding effect when moving between sets of screen objects. The navigational trail at the top of the screen was designed using a horizontal grey line to separate out selected items. Objects were sized in relation to their position in the trail. That is, each time a new object was added, all previously selected items would gradually decrease in size to emphasise their order (see **Figure 21**).
Realism continuity	This interface consisted of rich graphics, intentionally designed to appear similar to real world objects (see **Figure 22**). All screen objects employed different surface texturing, complete with shadow and motion blurring. Situated in a virtual space, advanced 3D animation allowed for the transition between room objects (which consisted of a wooden table, blackboard and a cardboard box containing sets of photographs). These were intentionally designed in a black environment to emphasise their position in the space. At the top of the screen, a shelf-type display represented the navigational trail. However, unlike in the *Abstract Continuity* version, all menu items selected remained the same size.
Realism non-continuity	Identical in the graphical design to the *Realism Continuity* layout, no animation or transitional effects were applied. Instead users would 'snap' (similar to the *Standard* layout in study 4) between screen objects[36].

Table 5: Description of layouts

36 It is important to emphasis that an *Abstract Non-continuity* interface was not developed for this study as it was felt this type of interface style already exists on current DITV services (i.e. simple shaped graphics, using navigation that snaps between screen objects).

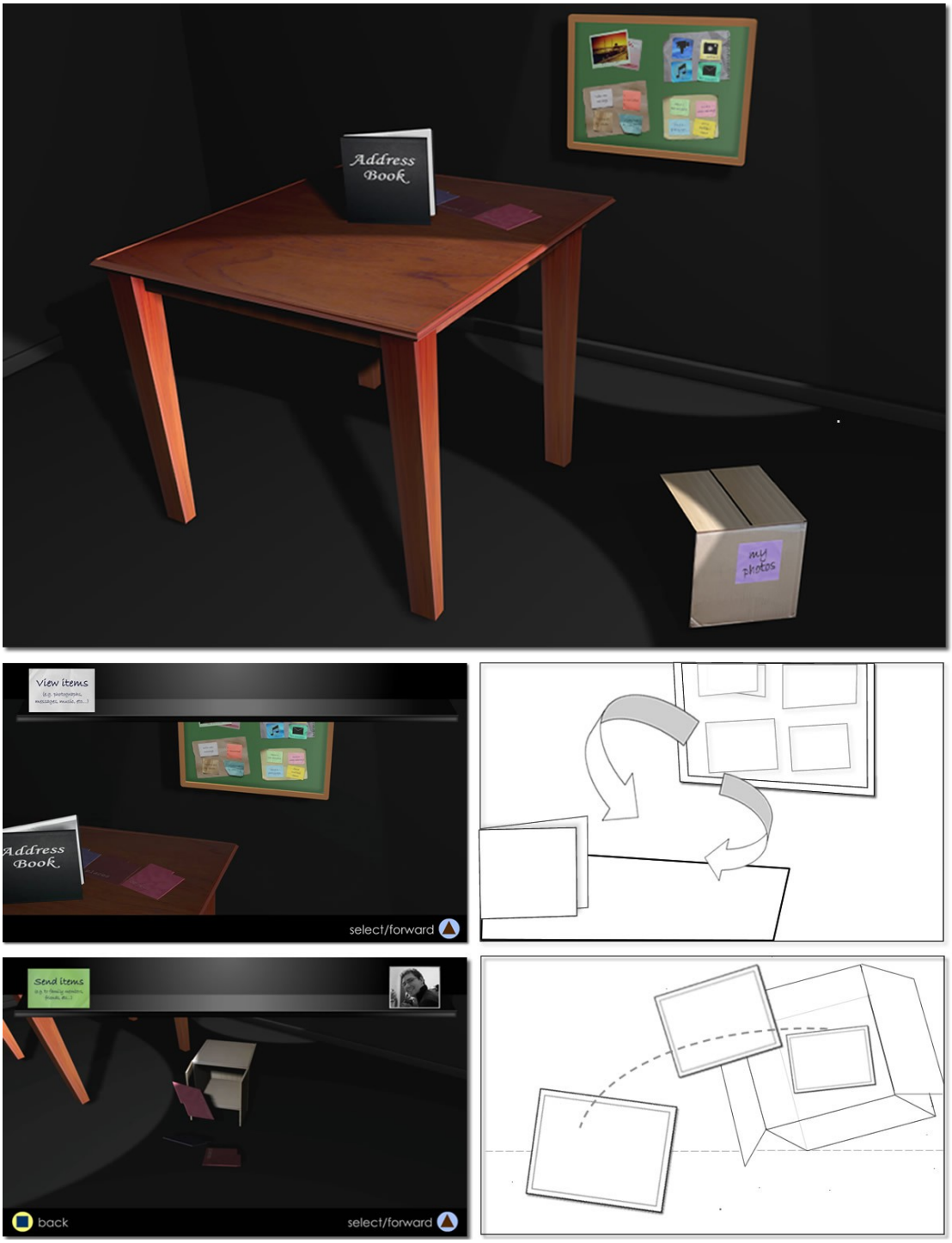

Figure 20: The virtual environment. (*Top*), the room layout; (*middle and bottom*), illustrations of transitioning through the 3D space. For example, moving from a notice board of menu items to a table where further objects are displayed; and moving from the table towards the floor where a cardboard box automatically topples over to reveal three sets of photographic folders (subsequently viewable).

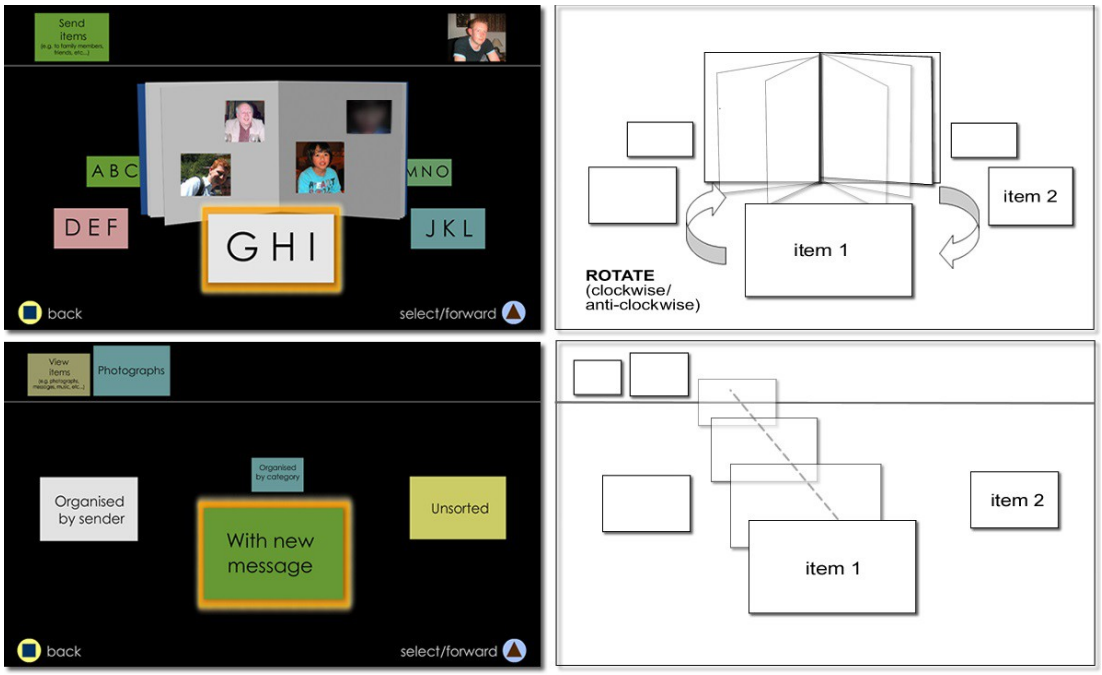

Figure 21: (*Left*), screen shots of the *Abstract Continuity* layout; (*top right*), in which alphabetical items can be selected by pressing the left and right navigational buttons on the remote control to smoothly rotate objects around the carousel. Each time the objects rotate one position, a subsequent page in the address book turns over. Contacts can be viewed and selected by zooming into the address book. As the book enlarges the alphabetical objects fade out; (*bottom right*), a small set of menu items. Once a menu item is selected, it zooms slightly forward, then prospectively back in the navigational trail. The size of menu items are reflected by their position in the trail.

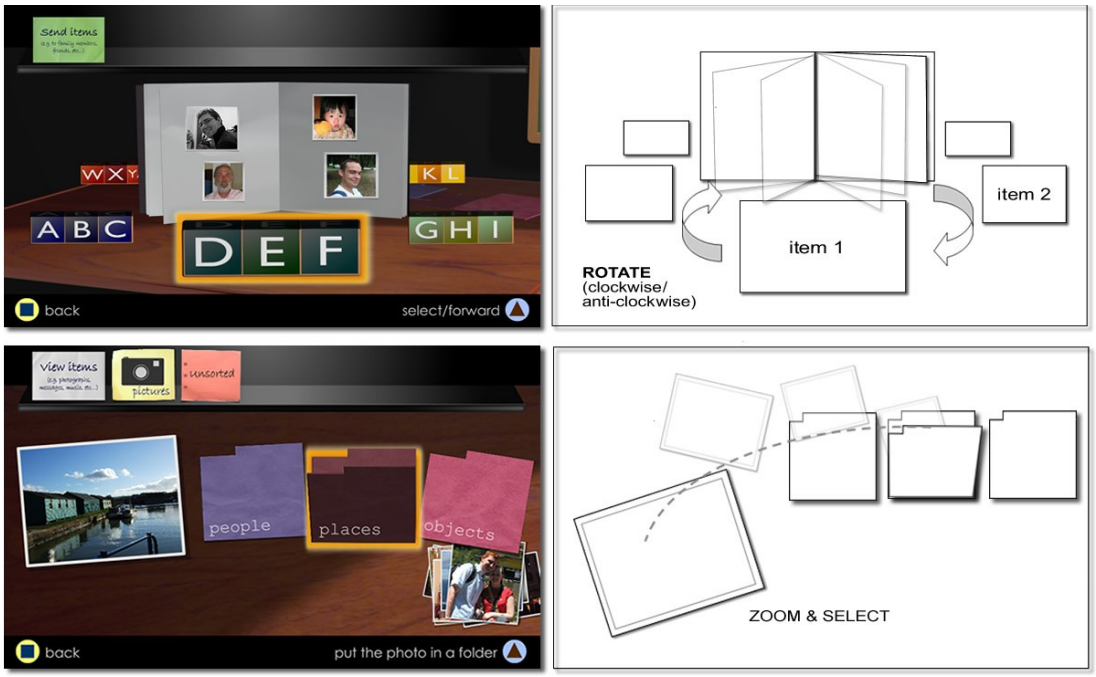

Figure 22: (*Left*), screen shots of the *Realism Continuity* layout; (*top right*), identical in movement to the *Abstract Continuity* in **Figure 21**, this layout uses rich graphics to depict on-screen objects. In the case of zooming into the address book, the user zooms into the surrounding space; (*bottom right*), an image can be selected from the row by pressing the left and right navigational buttons. Each time the highlighter moves to the next image, it becomes slightly enlarged (emphasising its selection). By selecting the image (forward button) it enlarges further and moves to the left of the screen, the remaining images simultaneously form a loose pile in the bottom right corner. The three folders also move down in vertical position, and by default the left one opens and is highlighted. Navigating left or right changes the highlighted/opened folder. By selecting a highlighted folder the photograph animates inside.

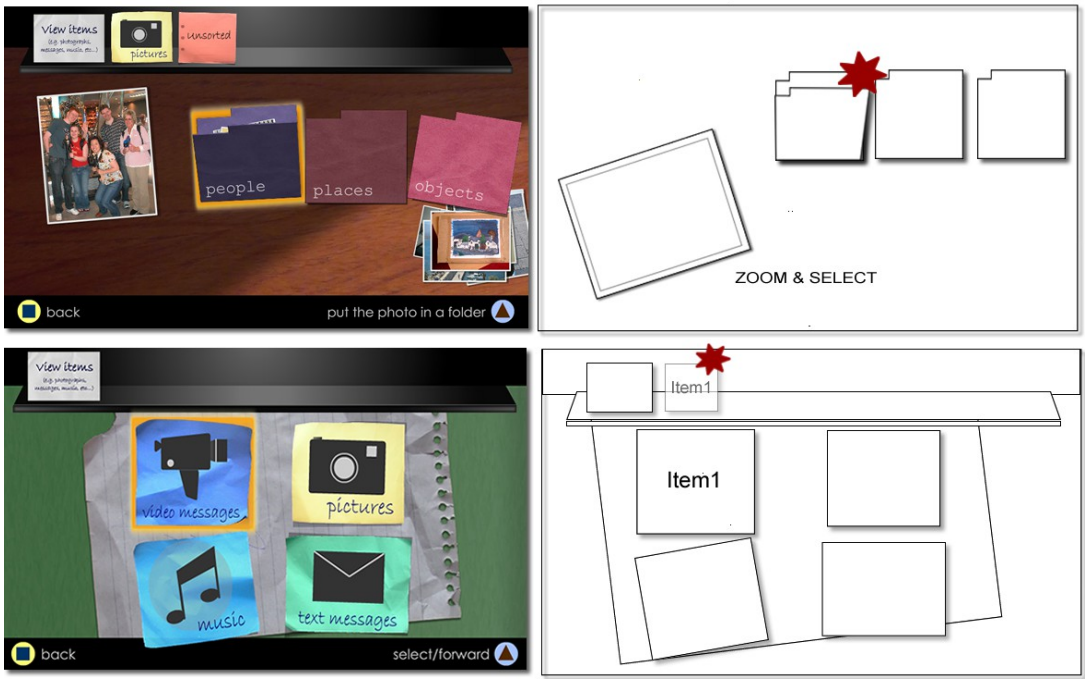

Figure 23: (*Left*), screen shots of the *Realism Non-continuity* layout; (*top right*), the same procedure as in **Figure 22**, the only visual difference is no animation is used. Consequently all images and folders 'snap' from one position to the next. (*Bottom right*), once a menu item is selected, it 'snaps' to the back of the navigational trail. In this layout, all the menu items displayed in the trail remain of similar size.

8.2.2. Software development

All layouts were primarily built in ActionScript (AS2) over a five month period. 3D objects were developed using 3ds Max 9, a 3D visualisation tool commonly associated with games design. As part of the development process, shapes were modelled and materials texture mapped appropriately from vector graphics (originally developed in Adobe Photoshop CE). Once complete, these scenes were rendered into QuickTime (.mov), and then convert into Flash video format (.flv) using Flash Media Encoder (see **Figure 24**). Finally, these files were imported into Adobe Flash where additional interactivity and scripting was added to include additional functionality. To ensure a working remote control, key event listeners in the ActionScript code were included to handle button presses, with support of a stand-alone serial switch driver connected to a PC via a local USB. As a result, the remote control was fully operational for this study. All interactive prototypes were displayed on a 26" LG wide screen LCD television (1024 X 768) connected to a single PC unit (1.6 GHz). Compared to present STB specifications, a

fairly powerful CPU processor was required to smoothly run the animation. However, as noted in **Chapter 3**, given the present problems of deploying 3D graphics in STB systems, the only realistic option was to run the software in a PC environment. Hence, in order to test the animation effects, present technical constraints were overlooked.

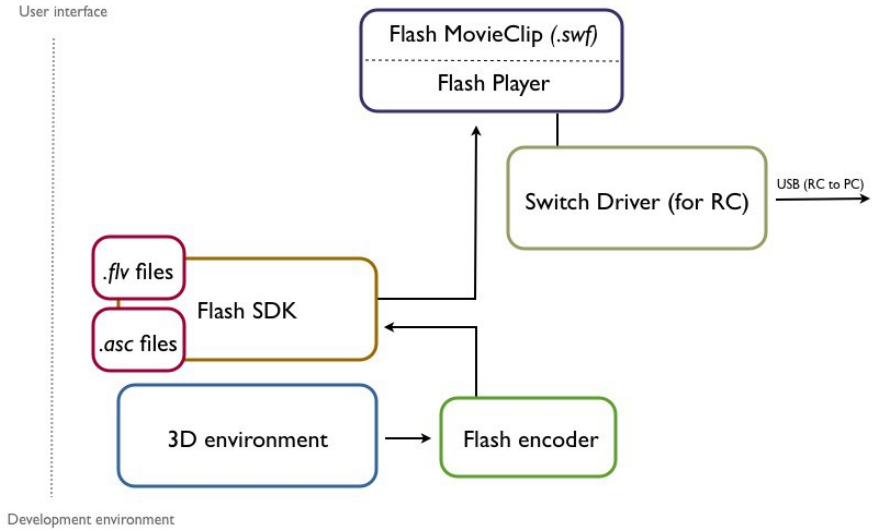

Figure 24: Diagram of the software architecture

For the remote control, small modifications included removing the previously labelled 'in' and 'out' buttons, originally colour coded as red and green. These were replaced by single shaped objects (see **Figure 25**), carefully designed with good colour contrast. Avoiding the use of labels, these handset symbols were replicated as on-screen icons with accompanying text, to further illustrate their functionality (see **Figures 21-23**).

Figure 25: Revised buttons on the remote control. The forward/select button consists of a square shape (dark blue on yellow), while the back button, a triangle shape (dark brown on light blue).

8.3 Procedure

Studies were conducted in May 2007. 18 participants (9 males; average age 71 years, and 9 females; average age 69 years), all of whom had been involved in one or more of the previous studies, took part in the prototype evaluations. Participants reported having limited or no computer experience. Fully informed of the procedure, they were asked for informed consent in compliance with the University of Dundee's ethical guidelines. Three pilot studies were initially performed, in which a number of minor glitches in the software programs were discovered and subsequently debugged prior to the final evaluations. Each session lasted approximately 90 minutes, and consisted of two stages. For the first stage, as a warm-up activity, participants were asked to categorise a small set of photographs. Following on, in the second stage, they were then asked to complete two tasks, repeated over three different layouts.

To begin, participants were given a small set of photographs, which consisted of 15 'snapshots' of people, places and objects (similar to the actual grouping of images used in the prototypes). Arranged in the centre of a small table, they were asked to look at these images and organise them into one or more group. Although these photographs did not belong to the participants (and were therefore widely open to interpretation), they were nevertheless encouraged to

arrange them into some kind of order. It is important to emphasis that this activity was only used as a mechanism to open up discussion and informally introduce the associated interactive on-screen tasks, and consequently were not designed for further analysis. To encourage discussion, participants were prompted to explain the grouping of images, as well as think about how they would arrange larger sets of data. A short activity, it was designed to take approximately 10 minutes to complete.

Participants were then asked to complete two tasks: i) find and organise four photographs (separated by people, places and objects) into relevant folders, and ii) find two contacts and send them both the same photograph. Each task was to be completed using three different layouts. In both cases, participants were reminded that relevant information had already been added to the 'system'. While the former task required participants to find and once found, organise a set of images, the latter consisted of first selecting the two relevant contacts, before the appropriate image could be searched for, found and subsequently sent to them. For each task, participants were required to search through a series of on-screen menus until they reached the appropriate screen (see **Appendix E**). Once the task had been completed, participants were then asked to return to the start screen. Unlike study 4, no demonstrations were given of the different navigational styles. This was intentional, in order to determine how easily participants would understand using the various layouts without any additional support or 'training'. To minimise the potential for learning bias, the presentation order of the layouts was counterbalanced.

Before beginning each task, participants were provided with full instructions, including a simple description using prompting cards (one per task), which included images of the contacts (including their names) and photographs to be organised. To encourage participants to remain focused, the author took on the role of facilitator, prompting participants when overarching difficulties occurred (e.g. when aspects of the task had been forgotten, or when they were genuinely lost in the system). After each task had been completed, a series of short questions

were asked in relation to their general understanding of the layout, as well as more specific questions related to particular difficulties encountered. After closing the application, participants were also prompted to recall what screen changes had occurred. These short discussions were thought a useful means of giving participants time to reflect on what they had undertaken, providing a short break from the on-screen interaction.

All sessions were undertaken in the usability lab, School of Computing (**Figure 26**), and were recorded onto High Definition (HD) video using a Sony HD camcorder and two separate microphones for audio recording, strategically positioned around the room. In addition, a web camera was also mounted onto the left corner of the television monitor to separately record the use of the remote control. This was recorded directly on to an Acer 1.5 GHz laptop. After each session had finished, all video and audio data was rendered and converted into Apple QuickTime using the video editing software, Final Cut Studio. In total, approximately 30 hours of unedited video data was captured.

For data analysis, some quantitative performance measurements were undertaken to examine the frequency and nature of errors that occurred in completing the tasks. These were divided between major and minor errors. Minor errors were categorised as errors that could be self-rectified by participants, while major errors were those that needed some intervention by the facilitator to be corrected. This type of information was largely used to support the observational data. Once again, given the sheer quantity of video, detailed descriptive notes and excerpts were partly transcribed by hand, to illustrate relevant examples and identify associated patterns of behaviour. Similar to other studies, these were based on transcriptions of the video.

Figure 26: Participants with facilitator completing the on-screen tasks (this includes a web camera positioned on top of a 26" television display and prompting cards mounted on a upright document holder).

8.4 Results

Given the role of the facilitator in prompting and encouraging user involvement, it is necessary to point out that results are subjective and open to some degree of interpretation. As such, beyond looking at the frequency and nature of errors, it is impractical to consider additional independent measurements such as 'time to completion', which otherwise could reveal a more detailed statistical analysis of the data. Further, error counts will be presented and discussed in association with observed user behaviour, however, there was no added value in additional statistical analysis, given the essentially speculative findings discussed.

Of the 18 participants, 14 managed to complete all the tasks within the time allocated, with the

remaining 4 having completed a minimum of one task per layout. Analysis of results revealed that, while the medians are more evenly dispersed, the *Realism Non-Continuity* had the highest overall distribution of errors, compared to the *Abstract Non-continuity* and *Realism Continuity* layouts with a lower, more equal distribution (see **Figure 27**).

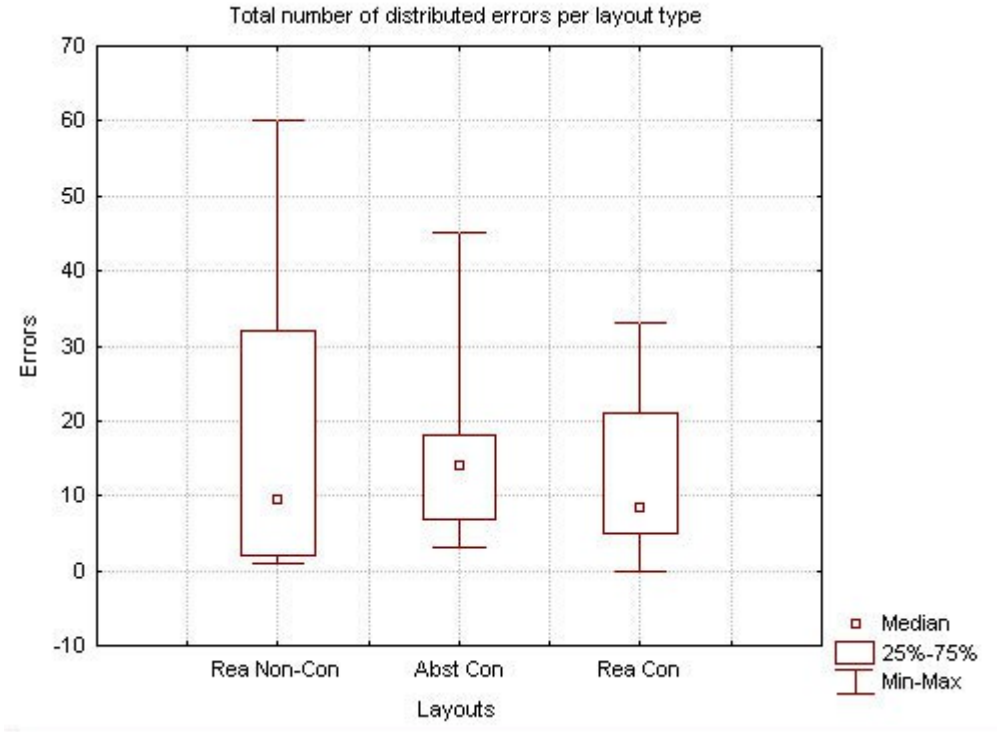

Figure 27: A graph showing the total number of distributed errors per layout type (Rea Non-Con = Realism Non-Continuity; Abst Con = Abstract Continuity; Rea Con = Realism Continuity).

Furthermore, the results seem to give good prominence to a learning effect, suggesting that the continuity approach may well have a marked impact in reducing the number of errors made. These results are substantiated in **Figure 28**, indicating a noticeable reduction in the total number of distributed errors between the first, and second and third layouts encountered (regardless of layout type), in addition to an overall reduction in the number of major errors per layout type and order, as reported in **Table 6.**

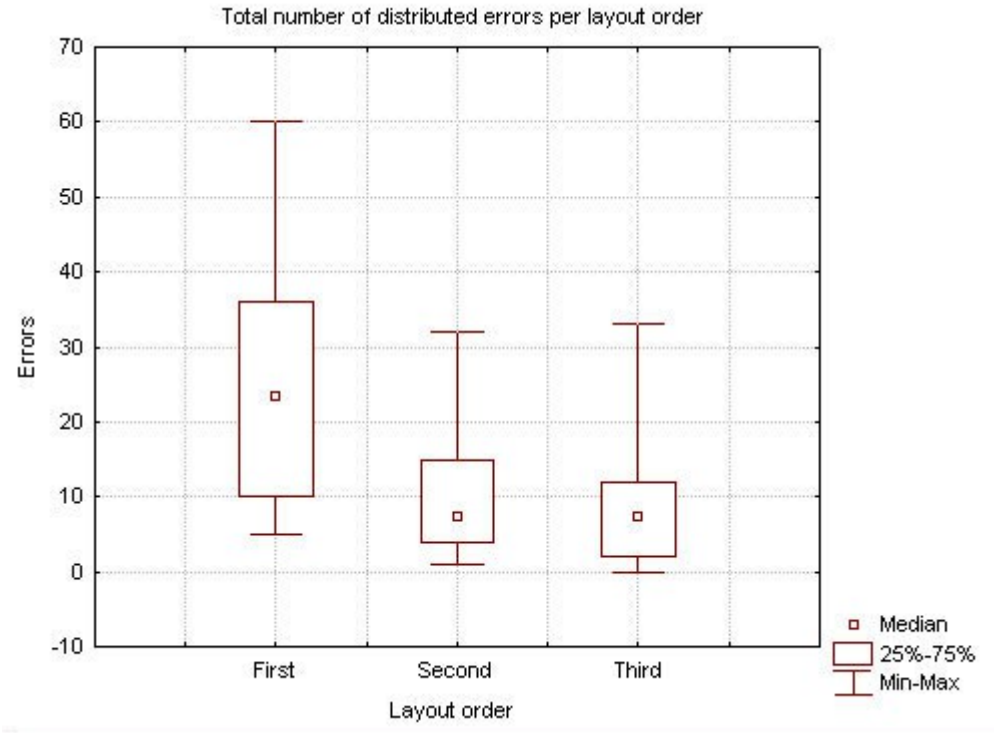

Figure 28: A graph showing the total number of distributed errors per layout order

Mean	Realism Con-Non	Abstract Con	Realism Con
Major errors per layout type	1.89	1.72	0.83
	Layout 1	Layout 2	Layout 3
Major errors per layout order	3	0.83	0.61

Table 6: Summary of major errors per layout type and layout order

Comparisons of the total errors per task (**Figures 29**, **30** and **Table 7**) illustrate variations based on the task complexity. The results for layout type and order highlight a reduction of errors for the first task, primarily associated as a simple information sorting activity. In this case, for the layout order, the *Realism Non-continuity* and *Realism Continuity* indicate similar distributions, with the *Abstract Continuity* demonstrating the highest number of errors, which may be explainable by differences in graphic and navigational styles (although at this stage, given the nature of the study, this is still speculative). By contrast, findings from the second task, both for layout order and type, illustrate a far more complex and uneven distribution of results, with the widest distribution of errors related to the *Non-Continuity* layout. This seems indicative of a far

more inherently complex task (regardless of the interaction), and the processes involved to successfully complete navigational steps.

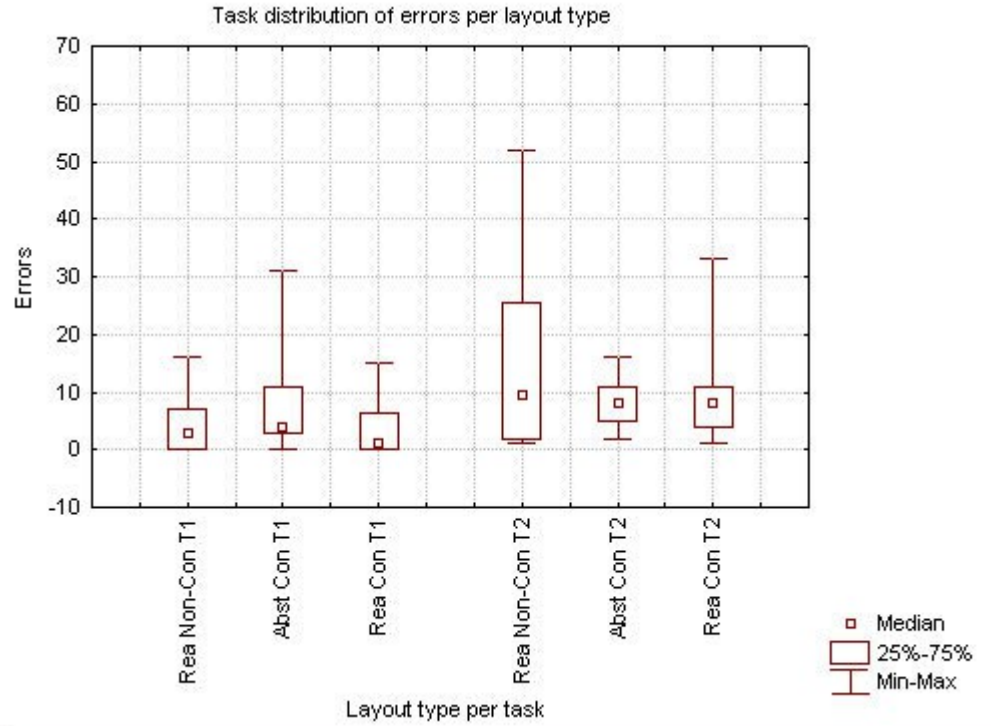

Figure 29: A graph showing the task distribution of errors per layout type (Rea Non-Con T1 =Realism Non-Continuity, task 1; Abst Con T1 = Abstract Continuity, task 1; Rea Con T1 = Realism Continuity, task 1; Rea Non-Con T2 = Realism Non-Continuity, task 2; Abst Con T2 = Abstract Continuity, task 2; Rea Con T2 = Realism Continuity, task 2).

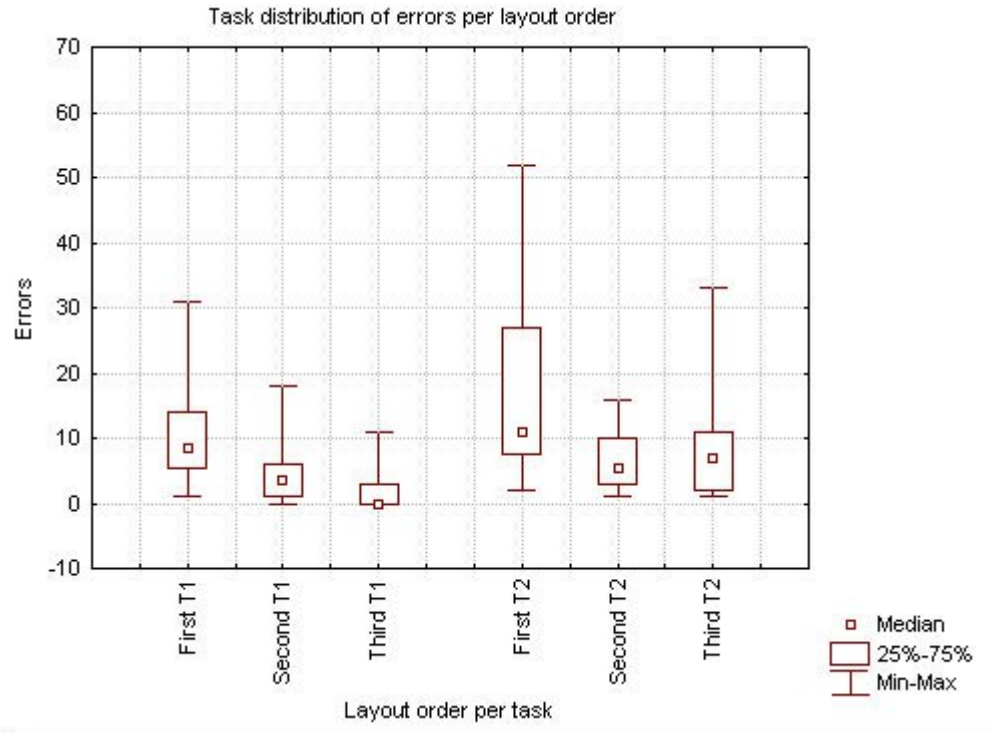

Figure 30: A graph showing the task distribution of errors per layout order (First T1 = First layout, task 1; Second T1 = Second Layout, task 1; Third T1 = Third layout, task 1; First T2 = First layout, task 2; Second T2 = Second layout, task 2; Third T2 = Third layout, task 2).

Mean	Realism Con-Non		Abstract Con		Realism Con	
	Task 1	Task 2	Task 1	Task 2	Task 1	Task 2
Major errors per layout type	0.25	1.88	0.65	1.33	0.25	0.73
	Layout 1		Layout 2		Layout 3	
	Task 1	Task 2	Task 1	Task 2	Task 1	Task 2
Major errors per layout order	0.94	2.44	0.19	0.75	0.06	0.71

Table 7: Summary of major errors of tasks per layout type and layout order

Given the qualitative nature of this study, it is important to emphasise that subjective improvements in performance are felt to be due to the familiarity and practice of tasks, rather than due to any difference in navigational style *per se* ("*I'm finding I'm concentrating on buttons better"*, or *"reading the instructions more"*). As such, many volunteers commented that they saw no noticeable changes in the layouts used, particularly in distinguishing between those with and without animation. Alternatively, differences identified could not always be easily expressed in words (*"I'm not sure why, but it seems easier to do"*, *"it's the same but different,*

how can that be").

Across tasks, the study indicated three separate examples that highlight the complexity of the continuity theme, and subsequently tries to illustrate where the animated layouts had a marked effect in aiding navigational comprehension. In particular, it examines the learning processes involved, emphasising that these were not just initial mistakes in using the applications. Visible in the first two examples (**Sections 8.4.1.1** and **8.4.1.2**), key to understanding the limitations of a snapping, non-animated approach (which cannot be feasibly represented by a quantitative error count), meant although participants had correctly completed many aspects of the tasks, they remained doubtful to what they had actually achieved.

8.4.1.1 Example 1: Sending a selected photograph to two contacts

In relation to the second task (see **Figure 31)**, the navigational uncertainties caused by the snapping effect was illustrated well by the envelope metaphor. Designed to signify that a photograph had been correctly sent by snapping over the two corresponding contact images, without additional on-screen confirmation, not only were participants unsure as to whether the image had become 'stuck' or lost in the process, but assumed that there was either an error with the software program, or more commonly a fault with the user in selecting the wrong button. Participants noted that the 'flash' of the red envelope on-screen seemed to instinctively indicate that something was wrong, while the snapping effect suggested that the image had been put in the envelope, but not correctly sent, as these comments indicate:

> *I noticed there was an envelope, came up there, is that confirmation that you've sent it... We'll there is red, would mean it hasn't been sent. Cos it's red, and red normally means, no. So it's not sent.*
>
> *I've put them in the envelope but have I actually posted them… have they actually gone.*
>
> *Glimpse of the two envelopes up there and it failed... I picked the right photograph, and I picked places, the only thing I can see is the select. I did that before and it bounced back… I am assuming this is all 'tickety-boo'. There are only two options*

it's either the system, which you say is OK, or operator. So it's the operator's fault… I would suggest that had it been the previous ones I would have got through. So there is an additional step required that I haven't done.

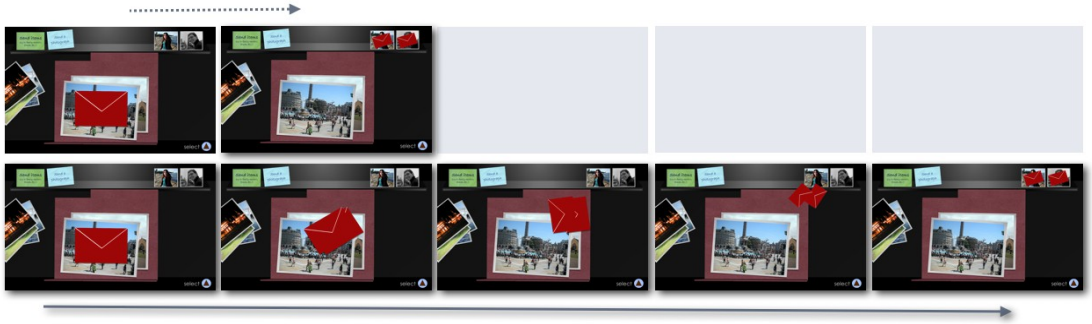

Figure 31: Example 1, variations of the animation effect. (*Top*), the snapping effect without animation; (*bottom*), animation used to depict the envelope moving over the designated contact images. For more details see **Appendix E**.

To complicate this issue further, the animated layouts proved largely insufficient to determine whether the task had been correctly completed. Consequently, participants were observed retracing through previous steps to gain some clarification as to whether the image had actually been sent, or not. Participants suggested that an additional ('unknown') step was required, such as sorting the group of photographs into some form of alphabetical categorisation (prior to sending the selected image), or searching through a 'filing system' to verify whether it had been received. These issues were reinforced by the display of menu items like *Send items* in the navigational trail, which were seen as a literal indication that the image had not been sent. Speculative about whether they represented information 'previously acted on', or 'to be acted on', in more extreme cases, it was assumed that pre-selected objects like *Send items* would automatically highlight, or animate over the two contact images to verify the task had been completed.

Reflected in the overall reduction of errors (see **Figures 29** and **30**), it is important to stress that, through the repetition and use of the animation, some participants felt there was enough information to successfully determine that the task had been completed. However, it is

necessary to treat the results with caution in terms of how much individuals initially understood the activity, given there was at least one instance where a volunteer felt confident the image had been sent, but when pressed on the issue, failed to explain what had actually happened. More commonly however, participants acknowledged they would have been more assured that the message had been sent, had there been more visual confirmation on-screen. This varied from the use of a simple text box to indicate 'message gone', 'OK' or a simple 'thank you', to a more realistic and imaginative means of extending the continuity concept to 'imprint' or 'insert' the image into the envelope before sending it.

> *If that has sent, that's fantastic, but just for that wee initial period, I needed something. Although you could say to yourself, 'Raymond what else do you need, you've seen the picture, you've pressed the button, you've seen the two envelopes going to the two people so it's sent'. Inside two, three times I'd say 'Raymond it's gone, forget it'.*

8.4.1.2 Example 2: Organising a small set of photographs

Comparatively, for the non-animated layouts, observations revealed similar problems to those previously identified in **Section 8.4.1.1**. To illustrate, for the *Realism Non-continuity* layout, the snapping of the selected photograph into the corresponding folder not only created more speculation and doubt as to whether the appropriate button had been pressed, but the resulting speed at which the transition took place led to the assumption that the photograph had been lost or accidentally misplaced. Lacking confidence, some participants wanted to back track, assuming an additional step was required, by viewing what had been previously put into the folder, or wrongly attempting to open the *View items* in the navigational trail (assuming this was also some type of folder). Unable to re-send the same image, disconcerted participants were observed re-positioning themselves closer to the television screen, in order to better determine what was happening to the next selected image. As such, it was reported there was an element of 'faith' that the photograph had been appropriately sent, in what was described as having 'gone in by luck rather than good guidance'.

> *The gospel truth, I haven't a clue.*

> *Did it go in? Turned my head away for a second... I was busy looking down and when I looked up it seemed to have gone. That's very disconcerting, cos I have no idea where it is.*

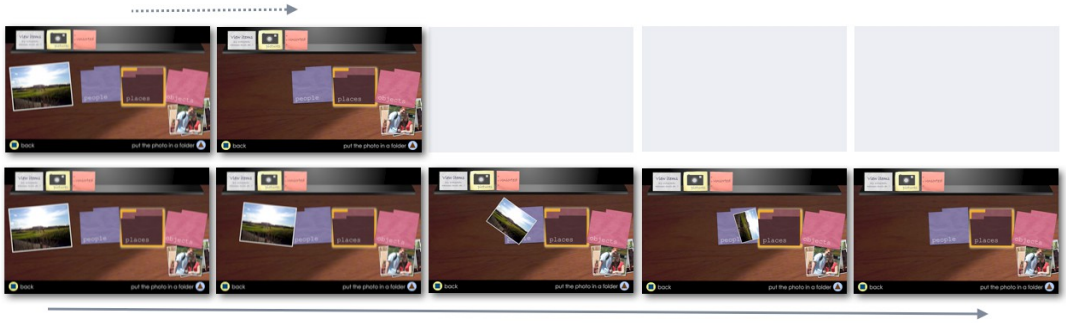

Figure 32: Example 2, variations of the animation effect. (*Top*), the snapping effect without animation; (*bottom*), animation used to depict the image moving into the designated folder. For more details see **Appendix E**.

By contrast, it was identified that those layouts with animation were far more explicit (and therefore successful) in demonstrating that the photograph had 'physically' moved into the associated folder, or what was described as a 'container' (**Figure 32**). Not only were participants far more assertive that the task had been successfully completed, but beyond initial 'teething' problems of knowing how to open a folder, or select the correct photograph from the set of images (issues identified across all layouts), individuals acknowledged far more clarity and understanding of actions taken.

> *At least you saw the things going into the folders, which was gratifying. I felt you actually saw as if you were doing it physically.*

> *...gives the person a great feeling to say I can do that, and to watch it, watch the picture go into the folder.*

> *Definitely helped you, the animation no doubt about it... and what you see you obtain quicker.*

8.4.1.3 Example 3: Using the address book

For the *Realism Non-Continuity* layout, evidence for the higher number of errors associated with finding and sending a selected image (see **Figures 29** and **30**) can be further attributed to

the negative effect the ‘snapping’ had on switching between screen objects. To illustrate, once participants had navigated to the open address book, unaware of the carousel feature, there was a tendency to either repeatedly zoom in and out of the first page selected (in some cases expecting to ‘flick over’ a page in the enlarged size), or to return back to a previous menu screen. In terms of the latter, and depending upon the number of times the ‘back’ button was systematically pressed, this would ‘snap’ users, often by default to the start screen (skimming past intermediary stages). Highlighted, the additional mistake of selecting *View items* rather than *Send items* (as later discussed in **Section 8.4.5**) meant participants would progress to an unrelated screen. Options to return back to the address book were then further hindered by a reluctance to press the ‘back’ button, assuming this might cause further disorientation.

By contrast, it was discovered that the use of the animation prevented users snapping back too far, for regardless of the number of times a button was pressed, no additional key events would be triggered in the program until the animation had finished. Consequently, this was seen to have a slowing, constrained effect on older users, in giving them more time to orientate their position on screen. These results seem to relate to the work of Bowman et al. (1997), who identified the negative effect ‘jumping’ between positions had on users spatial awareness in a virtual environment.

Related to the snapping effect, and being unaware of how to navigate through the address book, the tendency to repeatedly zoom in, and out of the default page led some individuals to speculate as to whether the on-screen contacts were the same as those illustrated on the prompting cards. This also led to some unusual patterns of behaviour, which included attempts to ‘pull’ a contact image into the highlighted index of letters, or select a specific image because it was perceived to represent a mother or father figure (and therefore assumed to hold more ‘instructional’ information).

> *I'm presuming that's mom up there...I'm thinking mom's going to have more to say, she'll have more gossip, so if I want more information that's the person I will get it from.*

Similar to the first example, the introduction of transitional effects used to initiate and demonstrate the opening of the address book did not necessarily provide the navigational assistance as intended. In this instance, the link between the animation and the task appears to strongly relate to the familiarity between the two. Surprisingly, (although not in all cases) many volunteers were initially unaware of the relationship between the alphabetical index of letters and the contact images displayed in the address book (almost seen as two separate sets of unrelated objects) (see **Figures 21** and **22**). Therefore, in a number of cases, rather than search for a contact by their initial (i.e. 'M' for Mark), participants took the more constrained approach of searching by image. This meant while many participants were aware of their presence, observations identified a considerable amount of repetition was needed to establish a connection between the related sets of information. In some cases, this took sustained practice with the different layouts (if identified at all). However, once realised, such concepts were described as being very self-explanatory, and were subsequently praised for their ease of use.

> *...I didn't notice first time around the alphabet, and I think that, that would get you to something quicker and that's clever. That's definitely clever.*

8.4.2 Recognised advantages of the animation

Despite having illustrated the tendency for limited awareness of differences in navigational styles of layouts, one of the key strengths of using the animation was the self-belief and assurance it created in knowing aspects of the task had been completed. As previously mentioned, participants talked about the gratification of knowing that they had achieved something, commenting on how the animation or 'cartoon stuff' provided a 'better kind of signal' in visually giving them time to think about what they were doing. In particular, compared to static pages (the problem of 'looking but not seeing') the animation was considered

as a more personal form of guidance.

> *When the thing came up first of all, it was not at all obvious to me that all the letters were going to be available, and the animation, just without flicking, the animation immediately made it obvious to me you know that they were all there, even though I didn't see them. One of my absolute pet hates is in Teletext… not Teletext, Ceefax actually. The bottom three lines in the news menu are all around. There are three, then they are replaced by another three, then they are replaced by another three… the technology of this is so blinking smart and 'cute', that you can start reading one line, it then flicks to three lines further on, and so you continue to read without realising it has changed, and you get a sentence that is completely meaningless… the animation lets you see what is going on, no question about that…I would get very accustomed to this.*
>
> *When you begin to crack it, it's very, very simple. It's like being at school.*

In comparison, although screen changes were identified with the non-continuity layout, the snapping between sets of objects caused additional disorientation, requiring individuals to pay more attention to recognised screen changes. In this instance, not only were objects reported to move faster, but they also seemed to have less direct association with the on-screen content. Examples included the circular movement of the carousel design, which undetected was thought to be a poor description of the navigational concept.

> *At the beginning I didn't know where I was going because I had no connection with the screen.*
>
> *I just hoped if I pressed the button eventually something that I would recognise would come up. Sort of my method of computing.*

In terms of animation, individuals expressed a preference for the movement of graphical objects, particularly with regards to the way the objects transitioned forward and prospectively moved away. Examples included the easing of the group of photographs across the screen, movement of a selected contact towards the navigational trail, and rotation of the alphabetical blocks around the elliptical carousel. Described as having a *"magical quality"*, the speed of the animation was praised for giving individuals time to think about what they were doing, related

to the idea of the 'computer doing all the work for you'. This meant on-screen actions were reported to be far 'less alarming' as participants described how they were better able to focus on the sequence of information unfolding in front of them.

> *You guys, you see you've got awfully clever, you've got these quick little brains that can think of little signals, but people like me need a little more 'cartoon stuff' to sort of give us a little bit of realism to the whole thing. I actually needed, 'I needed' to see those things going in, I couldn't believe, when 'you' could believe they had gone in, but I had no proof whatsoever they had gone in. As far as I am concerned they could have gone off into cyberspace never to be seen again. And I mean, OK I know people do this Teletext, just press a button and the thing's squirting out to New Zealand two minutes later, but you see somehow I can't bring myself to believe that.*

The layouts with continuity reiterated the importance of familiarity, and building upon recognised mental models, which helped to breed confidence in interacting with new design concepts. Remarks were made to the visual aspects of the prototypes in being far more intuitive compared to other computer-related systems. For those with related experience, parallels were drawn to affordances associated with hearing the paper scrunch up in the desktop recycle bin, as aspects of the graphical objects were seen to 'humanise' the screen, by providing more 'concrete' examples. Extending these real world metaphors, individuals questioned the feasibility to annotate text on the back of an on-screen image, such as by 'physically' turning over the object to write on it.

> *It's something I can relate too, it's something I'm familiar with, it's not so scary as something flying about. I prefer, again may be its partly to do with me being a little older, but, as things go a little more sedately you seem to have time to search around, I quite like that…anything you are familiar with is always better. And if that is a way you would normally do things, and that's imprinted in you and the familiarity is comforting, I'd be less afraid to transfer it to something else.*

> *Your eliminating things, as you would do if you're sorting these things* [paper objects]*…it humanises the screen to some extent…it's not just totally an inanimate object.*

In what was described as the difference between *"training and actual"*, the use of the animation

was thought of as a very useful means to equip novice users with the skills and confidence necessary to learn a new system. In particular, there was a distinction between a very controlled and defined beginning, in which it was argued that something new can never be too slow, to the use of 'speed' (i.e. no animation) and 'short-circuit' (referring to shortcut) options when users became more accustomed to the application. Although initially drawn towards functional understanding, like any system, there was an expectation that these types of application would be easy to use after two or three practices, despite evidence of the complex learning and unlearning strategies applied during this study. This suggests that simply 'cutting off' the animation after a few attempts is an over simplistic view of how easily participants would comprehend a more complete and sophisticated system.

> *The animation is a starter, once your confidence grows your then looking for speed, and the last one was speed* [the non-continuity layout].

> *It's fine to see them going into the folder…it's great to see them because you know yourself their away, but after a week, six, seven, eight days, you say is there not a button I could bypass that…but you need it at the start.*

> *First impression it's confusing, because of, I suppose a certain 'strangeness', and unfamiliarity. Now, virtually any system has some logic in it, you could get used to the thing. When you sit behind a car, and somebody says go to third gear or something and you don't know, but now you can do, sort of unconsciously… so familiarity in this case, does not breed contempt, it breeds confidence.*

8.4.3 Criticism and constraints

In contrast to the positive reactions of the animation, observations indicated issues relating to attention and information processing. This meant that important details, particularly at the beginning of the first set of tasks, were often missed. To some degree this is unsurprising, given the presence of the facilitator and the nature of the studies, both in terms of the novelty of 'experiments' (including users lack of specific knowledge about the system), and combination of different navigational styles requiring sustained effort and learning from participants. Further, this very much relates to the confusion older adults are known to have in separating out new

from old forms of information in the completion of new interaction, caused from interference and the build up of different memory cues and cognitive demands (Carmichael 1999). As such, it seems unsurprising that many of the older users experienced similar problems recalling screen changes and distinguishing navigational differences between layouts.

For example, over two thirds of the participants failed to acknowledge travelling through a virtual space, commenting that they were concentrating to much on what they were doing, not on how the information was being presented (e.g. *"I focus on one thing and I'm oblivious to everything else"*). This is somewhat surprising as a number of individuals were observed pressing buttons during the animation sequence, when traversing through the 3D environment. By contrast, a considerable amount of repetition was necessary to correctly identify the transitional movement of selected objects in the navigational trail (referred to as 'cast boards' and 'made memoirs' [i.e. aids to memory]), or the connection between the alphabetical index of letters and contact images displayed in the address book (see **Section 8.4.1.3**). While further research is required, it is believed part of this problem appears to relate to the running of multiple effects, such as the movement of a selected menu item towards the navigational trail, in conjunction with the gradual switching between target objects in the virtual space (see **Appendix E**).

In hindsight, it may have greatly helped to separate out these transitions, one at a time, such as in the more successful example of transferring an image into its corresponding folder (as reported in **Section 8.4.1.2**). For older people, it is also worth recognising that, in relation to differences in spatial ability that may influence task performance, the lack of 'configural knowledge'[37] to judge the direction and positioning of objects in a 3D environment has been previously identified (Sjölinder et al. 2005). While not focused on older adults *per se*, empirical studies examining distance perception in virtual (and real) environments have also found

37 Configural or survey knowledge is the directional sense required to navigate between different geographic locations based on the relative positioning of objects in the environment (Sjölinder et al. 2005).

significant limitations in users' estimations of the walking time required to reach a set target point (Plumert et al. 2005).

In relation to the stereotyping of older adults as reported in study 3 (see **Section 6.5**), assumptions were made that many older people would prefer to 'snap' between screen objects to keep their minds active, or because it was argued, they would not be aware, or would become impatient with the use of transitional effects. While these claims are unfounded, unlike younger people who would appreciate a more complex system, there was an expectation that at least some older people would want 'simplification' and 'nothing fancy'. In one case there was also a dislike for what was referred to as the 'jerkiness' of the animation (e.g. the movement between sets of on-screen objects, such as between the notice board and table), which was thought to be both distracting and unnecessary. In this instance, the idea of 'floating' between objects was thought to be time wasting, compared to a more direct snapping approach.

As in study 4, working with older volunteers uncovered a number of limitations. While these were not necessarily impacted by the animation, they nevertheless had an influence on the task performance times of activities. To summarise, they included:

- Frustration towards the repeated number of navigational mistakes, self-conscious that errors made were due to personal incompetence rather than poor design (*"I'm just being old and stupid"*, *"I should have noticed that, an idiot like me would be doing that all day"*). In these cases, a lack of confidence meant a considerable amount of encouragement was needed for participants to persevere within tasks, and redirect them back when a major error had occurred.
- Repetitive prompting to remind participants of the photographs to be organised, or contacts selected (illustrating that the display of the prompting cards were not enough). This was particularly important in a few cases where individuals were reluctant to continue, wanting to be almost 'spoon fed' answers to the problems they encountered.

- Reassurance of what they were doing was correct, and that mistakes made were not uncommon amongst other users. As a result, many individuals were keen to point out what they wanted, or were trying to do. However, this should not be confused with the think aloud protocol (TAP) of describing what they were 'actually' doing, of which participants rarely did.
- Far more positive towards the activity after the task had been completed, at times contradicting themselves. This included variations of answers in the discussion period, from a one or two word summary, to a detailed and articulate response.

8.4.4 Use of graphics

Based on the subjective feedback given, the studies found no significant differences between the use of abstract and more realistic graphics to aid navigation. This is supported by participants who acknowledged physical attributes in the simple shape representations, such as the imitation of a photographic folder opening and closing. This is somewhat different to the earlier desktop work of Gonzalez (1996) who proposes that animation should be based on realistic rather than abstract imagery (although she is aware this may be dependent on the task domain). Given such issues, preferences for the use of graphics were largely based on aesthetic appeal, in which minimal and richer, 'real world' styles where reported to have excellent text legibility. Furthermore, a few participants saw no problems in using abstract shapes to depict real world objects within a 3D, virtual environment. However, given the problems of getting individuals to recognise moving through this space, it is unclear whether more abstract forms would be familiar enough. To accommodate, one option was to 'upgrade', or customise on-screen graphics based on the user's personal preferences.

8.4.5 Labelling of menu items

Beyond the use of the animation *per se*, issues in relation to the labelling of graphical objects were also identified. Despite carefully limiting the number of linear menus in the application,

one of the most common misunderstandings on the start screen was the distinction between *View items* and *Send items*. For the task of sending a photograph to two contacts, strong analogies were made that the user would first have to view an item before they could send it, assuming that *"you can't send something to someone until you know what to send them"*. This was supported by comparisons to using email, and the principles of writing a message first.

> *...like binary, one* [contact] *or a zero* [photo]. *I either have to do this first, or that first, that's only two choices... and I've managed to get nothing.*

A common misunderstanding of selecting the *View items* (rather than *Send items*) meant participants would navigate deeper into the wrong part of the application. This included the ambiguous labelling of items like 'pictures' which, similar to the *Standard* layout in study 4, were wrongly interpreted to refer to the pictorial labels of selecting the contacts requested (and not the multimedia, i.e. the pictures themselves). However, selecting this item only deepened the speculation over what to select next. Often unable to self-rectify the on-screen errors (if recognised), at times a considerable amount of prompting was needed by the facilitator to redirect volunteers, as observations identified a similar pattern of behaviour over the duration of tasks. To address this issue, one suggestion was to change the presentation order of the menu items, so users were more inclined to select *Send items*. However, a temporary solution, regardless of the task, it does not account for the possibility that on a 'real system', either item could be chosen first.

> *...logic would say to me then that if this is the interface I would have that first, send items. Although you might say well you've got to look at what you send before you send it. You see what I mean. That's purely initial reaction, and that's what you're wanting.*

Similar problems were also observed when selecting different sets of menu items during the first task of organising a small group of photographs. When presented with the four menu options - *With a message, Unsorted, Organised by sender and Organised by category,* observations identified participants would commonly choose between the latter two items (both designed to

refer to previously arranged multimedia in the system). Rather than correctly select the *Unsorted* category, beyond misreading the labels (i.e. *"I thought it said 'organise' not 'organised'"*), like the previous example of writing a message before it was sent, it was commonly assumed that photographs would first have to be found and put into some kind of order before they could be viewed. For example:

> *Well they're unsorted that's perfectly all right, but if I am sending them, do I organise them myself, or do I organise them by category? You see I could be doing either one… they're unsorted that's what I've got, but what I want to do is to organise them.*

Beyond the confusion over the ambiguous menu labels, in terms of sending a photograph to two contacts, while participants recognised the movement of images, a lack of on-screen prompting meant individuals were often uncertain which direction they moved out of the folder. This caused a number of navigational mistakes, which were repeated across tasks, and consequently accounted for a number of minor errors made. In hindsight, constraining the movement of images out of the folder to the left of the screen could have been overcome with a more explicit navigational prompt, such as in the physical world, the ability to sort the images into one or more designated piles (e.g. by orientating images to the left or right of the folder).

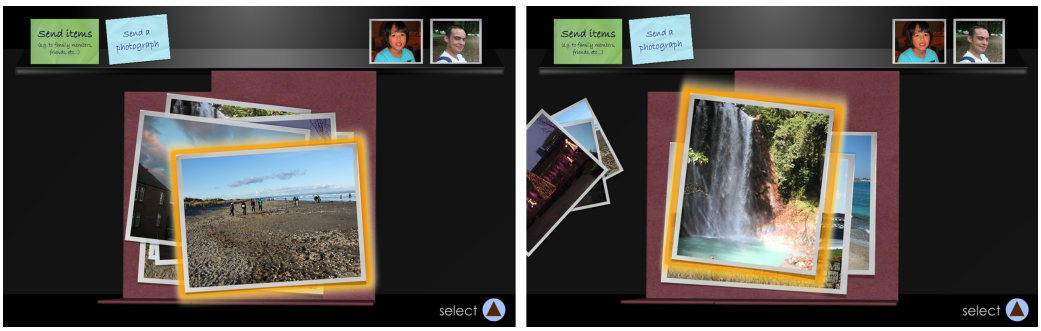

Figure 33: Sorting images out of a folder. The left directional arrow button sequentially moves images to the right. To move back, the right button is pressed.

8.4.6 The remote control

Similar to study 4, users overwhelmingly praised the remote control for its ease of use and

design simplicity, as observations found individuals had no pragmatic difficulties in switching between TV and remote control interfaces. Although not a primary focus of the study, options to amend the remote control included the use of an additional ‘fast forward’ or ‘fast back’ button that provided a speedier return to the start screen, distinct ‘select’ and ‘forward’ buttons to separate the dual functionality of the current ‘forward’ button on the remote control, and additional screen confirmation when a correct button had been pressed (i.e. by lighting up a LED on the handset display).

As with the previous study, similar mapping issues were identified in the carousel, whereby some participants incorrectly attempted to select menu items at the back of the elliptical design, and very commonly, to select items before aspects of the animation had finished. These issues were reinforced by the assumption that the on-screen menu items were directly mapped to the directional buttons on the handset, in what were referred to as the ‘four compass points’. Given the remote control buttons were intentionally designed to avoid more explicit and fixed labels as with standard controls, some difficulties were encountered in memorising dual functional buttons, particularly as on-screen instructions were not always recognised or correctly interpreted. These issues can be linked to the learning/unlearning of tasks, which must also be accountable to differences in navigational styles across layouts.

A good example of the differences in behaviour included misinterpreting the navigational movement of the highlighter in the address book (to the extent of knowing the ‘right’ directional button moved the highlighter ‘right’), as doubts were raised to why pressing more than one button only moved it once, or not at all. With attempts made to trace through the sequence of navigational steps taken (at times, misinterpreted), variations amongst participants also meant some appeared (at least initially) quite erratic in their button presses, compared to others who were far more selective or hesitant in what was chosen. Related to the learning and unlearning of tasks and the thinking processes involved, to stop participants straying too far, a dialogue box would appear across the centre of the screen instructing users when a wrong menu item had

been selected. Removable by moving the highlighter to the adjacent menu item, in practice the sessions discovered that participants would commonly attempt to remove this object by pressing the ‘forward’ or ‘back’ buttons. In this instance, while pressing ‘forward’ had no functionality, ‘back’ would return the user to a previous menu screen. Participants were therefore observed repeating a similar pattern of behaviour, often associating ‘back’ with a loss of previously selected content, thus creating additional anxiety over the ease of retrieving this presumably lost information. To demonstrate, in a more extreme case, reluctant to go back, one participant was observed to be physically shielding the ‘back’ button with his left hand, to prevent himself from accidentally pressing it during the task.

While individuals were often able to resolve these issues by themselves, such examples illustrate the potential problems that may arise with a much more complete system, visualising much larger data sets of contacts. Similarly, it demonstrates the divisions between the ‘explicit’ and ‘implicit’ labelling of remote control buttons (and the associated memory processes concerned with ‘learning’ and ‘recalling’ such labels), as it seems highly feasible that many users will have, rightly or wrongly, conceptually labelled functions to draw out associated meaning. Yet, despite the early draw back in the mapping of buttons, it is important to emphasise that while implicit prompts may take longer to recognise and understand, in the long term they may better enable older users to retain this knowledge and apply it in the learning of new situations, applicable to this system.

8.4.7 Customising photographs

The warm up activity of sorting a small group of photographs proved useful in getting volunteers to relax, and on a very generic level, to help them to describe how they organised personal collections of images. Many volunteers reported to have up to hundreds of paper-based images boxed or stored away in the attic, a briefcase or a cupboard, some of which were methodically ordered, while others were described as still being in their ‘Kodak packaging’. For the photo organising activity, categories were commonly divided into single piles of people (or

friends and family), places (or buildings), holidays, or alternatively by year or date. To round up the session, given the potential for customising much larger sets of data, questions were raised as to how participants would organise a larger amount of information, viewable at any given time.

Overall, while answers were divided on this issue, the majority of participants recognised the importance of sorting out information appropriately. One possibility, comparable to physically organising photographs, meant they could first be sorted into separate piles, with an option given to eliminate those images not needed. This included having an overall category, from which photographs could be subsequently divided within. In this regard, descriptions were made for adding 'sub-groups' within a default folder, assuming more folders would make images easier to find. Vague comparisons were also drawn towards the desktop computer, including suggestions to using albums and thumbnails sets (in what were referred to as 'clusters', 'miniatures' and 'poly filters') by allowing users to 'click' through multiple items using an on-screen directional arrow, in one case based on the familiarity of viewing images on a digital camera.

On the other hand, it must be stressed that a lack of computer experience was exemplified by wider uncertainties over how to add additional content, or sub-divide information appropriately, as some individuals were more concerned towards the complexity of adding further features. Providing nothing new to the research, this gave them the opportunity to emphasise the importance of design simplicity, and reiterate difficulties with using modern day technology. As a result, similar to previous studies, particularly study 4, and the discussion of alternative input devices, it reinforced the problems of getting participants to think beyond the constraints of what they know, or have difficulty imagining. Consequently, practice with the layouts disappointingly failed to trigger more significant ideas on this subject.

8.5 Conclusion and discussion

In relation to the original hypothesis, results indicate that, while on average more errors were made with the non-animated layouts (causing additional disorientation), this depends upon the complexity of the task and order of layouts used. By contrast, this research suggests there are particular transitional effects based on the familiar movement of real world objects that seem to help build confidence and understanding of the related navigation and interaction. At the same time, it is clear that not all the animated effects were identified or clearly understood. Noticeable examples included transitioning along predefined viewpoints in the virtual environment (which in fairness was only implemented in the *Realism Continuity* layout), or recognising the connection between associated sets of screen objects. This included identifying the relationship between the contact images in the address book and index of alphabetical letters displayed in the elliptical design (e.g. see **Figures 21** and **22**).

Across the counterbalanced tasks, while the results indicate a learning effect across the presentation of layouts, observations found that participants could be quite error prone at times, repeating mistakes, not only within, but also between tasks, which in the latter stages of the session may well have been attributed to additional factors, such as fatigue. In extending findings from study 4, observations reconfirmed the disorientation caused from the snapping between sets of related graphical objects. However, practice with the animated interfaces appears to have bred more confidence and understanding of navigational styles, indicating the snapping effect was less disconcerting through prior practice (assisted by animation). At the same time, given the qualitative nature of this study, there were numerous occasions when participants had unknowingly completed a task when there were no animated cues.

There were strong indications that similar aspects of the animation resulted in different degrees of clarity and understanding, namely the process of sending an image to a corresponding folder, compared to an equivalent envelope being sent to two contacts (see **Figures 31** and **32**). Despite using similar transitional effects, one explanation for this variation appears to relate to the

abstraction of a red envelope fading in from a selected image and perceptually rotating across the screen to two contacts. Supported by remarks that the image had not been sent because it hadn't been put into the envelope first, this demonstrates the importance of exploiting prior knowledge of known procedures, to aid in the visual understanding of new and unfamiliar situations.

By comparison, in organising photographs, selecting the photograph to naturally orientate into a folder was seen to simulate or resemble a more realistic imitation of a physical experience. Indeed the results strongly relate to the paper prototyping activity as reported in **Chapter 6**, in having identified strong comparisons to conceptual models of the telephone as a communication device. Supportive evidence that compared to more static or abstract representations, graphical objects that embody, or share, similar physical properties to their tangible counterparts in terms of orientation and movement (in this case the equivalent of grabbing a physical object) may help novice users follow the 'flow' of interaction.

To further address the effects of the continuity concept, and more broadly the question of how animation can optimally help older users build up mental representations of relevant information, more quantifiable research is now needed - particularly in comparing performances in different age groups, such as the distinction between younger old (55-75 years) and older old (75+) adults (and possibly including measures of prior PC use). This should also involve not only a much larger sample size, but also a more constrained set of independent measures, including the use of training sessions to ensure older adults have more equal grounding of the navigational styles before the layouts are subsequently tested with subjects.

Of the various guidelines and recommendations available to improve the usability of 3D and VE environments (e.g. Vinson 1999; Sayers 2004), little consideration has been given towards the requirements of older adults beyond desktop applications. In transitioning between screen states, variables such as animated speed (Bederson and Boltman 1999) and types of visual cues have

been identified as important visualisation mechanisms to highlight and contextualise screen objects (Cockburn et al. 2008). While the results may indirectly crossover with other HCI research findings (that have studied the effects of visual navigation on spatial-orientated tasks), further research on the impact of continuity requires more detailed considerations regarding older adults, which should include:

- **Fluidity and speed**: the smoothness and velocity of animated effects so as not to irritate or distract on screen interaction.
- **Duality of movement**: the implications for attention and spatial ability to simultaneously run one or more types of transitional effect.
- **Graphical quality**: the level of realism needed to depict recognisable movement of 2D objects within an associated space.
- **Multimodality**: the extent to which additional auditory cues may aid interaction in helping to draw attention towards relevant on-screen changes.
- **Learnability**: the number of repetitions needed to correctly identify an animated effect.
- **Adaptability**: the extent to which older users should be given the option to customise the speed or types of animation used. This includes whether certain forms of animation may become counter-productive over time, hindering interaction or becoming a nuisance.
- **Complexity of tasks**: the extent to which more complex procedures may rely on more effective animated approaches.
- **Input control**: the relationship between the on-screen content and interactive mapping of associated operations and functions through 'physical' gesture or other 'hand held' devices (see **Section 9.4.2**).

By contrast, in terms of eliciting ideas, reviewing the process of working with older adults, the results reiterate findings from the previous chapter, demonstrating discrepancies between the subjective feedback and observational data collected during tasks. Most notably, the research

illustrates the potential skewing of results, given participants were found to be far more positive towards what they had experienced after the event, assuming this was based on task familiarity, rather than differences in the design of navigational layouts *per se*.

Undoubtedly, while rich descriptive data was gathered through out the sessions, without taking away the validity of information acquired, the lack of differentiation towards the navigational styles does bring into question how well some older adults can critically articulate the experiences they have encountered, given, based on the evidence of this study, user feedback taken at 'face value' has a clear potential to bias results. In this regard, the role of the facilitator was found to be decisive in gently redirecting participants when a major error had occurred, preventing them from becoming too de-motivated or disoriented in the associated application. However, as previously identified in **Section 7.6**, this does raise some speculation over the extent to which a more complete system will disorientate users further, bringing into question their willingness to persevere within a task.

Similar to exploring the range of possible input controls as reported in **Chapter 7**, in this study the prominent issue of dealing with much larger, and hence complex sets of data, to be viewed, annotated and stored on a STB system, largely failed to draw out more insightful ideas. In many ways, these findings fall in line with the results of previous studies in this thesis. Namely, the overarching problem of getting older adults to conceptualise ideas beyond existing and familiar phenomena of which are directly recognised or understood. However, what was particularly noticeable during this study was that even with the familiarity of organising electronic information on a 2D screen (a new experience for many), it was not enough to spark more creative, 'off the wall' thinking. Therefore, while comments drew out connections to the process of organising digital to physical imagery, others assumed that computer-based features were equally applicable. As such, these limitations in reasoning reconfirmed the ongoing challenges for broadening older adults ways of thinking about mental models of new technology, and eliciting new ideas based on their related expertise and background knowledge.

9. Conclusions

This chapter summarises the work by revisiting the original research questions outlined in **Chapter 1** of this thesis. Firstly, it begins by describing the overall contributions to knowledge. This is followed by a review of each research question, whereby recommendations and potential future work is discussed. Finally, this chapter concludes with a summary of the PhD project.

9.1 Contribution to knowledge

This thesis directly addresses the problems of gathering requirements from technologically inexperienced and reluctant older people in the design of technology for the home. Specifically, it addresses the challenges of working with older adults to formulate new ideas in the development of social application areas for digital interactive television. As a domestic technology, this is remarkably different to the technical and operational task orientated activities associated with the desktop computer, despite the design of TV applications remaining strongly based on PC metaphors. Thus, the problem is addressed by developing more exploratory methods for engaging with end users in the design process. As a result, the five studies reported in this thesis have not only explored methods to gather early requirements from older people, but also in evaluating navigational approaches to improve the interaction of poor usability and accessibility features of current digital TV systems. This is done by explicitly focusing upon social application areas favoured by the target group. Explanation and answers are continually sought for novel ways to generate new insights to maximise the involvement of older people within the design process. At the same time, close attention has been paid to the limitations and constraints in the methods applied.

9.2 Bridging generational differences

The initial question that was established at the beginning of this thesis grew out of a lack of literature and understanding in the user-centred design process in terms of how to maximise the involvement of older users, specifically in the development of non-desktop applications.

Question 1

How can designers and software professionals gather requirements from older people unaccustomed or reluctant to using 'digital' technologies, particularly in the design of new applications that are either undeveloped or undefined?

Given the complexity of this question, and given the broad heterogeneity of the older population (in relation to ability, expertise and more general experience with technology), it is not possible to provide a specific answer or solution. However, as this thesis has illustrated through example, more innovative methods are necessary to challenge the preconceptions and misunderstandings of many older adults. In order to address the wealth of 'unknown' technological possibilities during requirements gathering, there is a fundamental need to move away from presenting participants with more formalised ideas conceptualised by the designer or research team, to exploring more creative and physical means of engaging with them. This requires that older users take a far more active and central role in the development of new technology, by focusing upon conceptual understanding and related technological experience, which might not necessarily be related to modern day 'digital' systems. In beginning to address these issues, a significant part of this thesis has been to visually convey ideas in a manner that encourages participation and the resolution of design problems based on individual and group interpretation. This is fundamentally different to explicitly asking an older person to describe how they would like an application to 'look or feel', when they simply don't know, or have great difficulty answering.

9.2.1 Discussion

As discussed in **Chapter 4**, having identified the limitations of getting users to envisage possibilities for new types of DITV applications using traditional interview and focus group techniques, more visually orientated methods were required to give better insights when interacting with older users. Subsequently, **Chapter 5** began to address this issue by exploring the attributes of live theatre as a means to contextualise how technological uses can be

embodied by the actions of fictional characters, in the absence of prototypes. As such, it is felt that dramatised stories present many possibilities for designers developing new technologies, by allowing members of the audience to reflect on specific elements of a story. However, this is not to say that important interaction issues cannot be highlighted in the process. Indeed, for this thesis, live drama flagged up a number of social and technical issues associated with the digital medium. As such, given its exploratory nature, further variations are likely to bring promising results, by allowing older adults to formulate a deeper comprehension and association with aspects of the technology in question.

In **Chapter 6**, brainstorming and paper prototyping techniques were used with small sets of users to build on conceptual knowledge of specific aspects of an application. Subsequently, it is believed this intertwining of both verbal and visual modes of communication enabled a richer translation of ideas. As an open ended process, brainstorming through the aid of prompting cards helped participants to contextualise their understanding of an associated system. Sketching, although reported to have noticeable weaknesses, had the advantage of revealing features that may be difficult to describe or express easily in words. Although crude, these drawings became a good focal point of discussion, in making abstract concepts more concrete. On the other hand, the arrangement of graphical cut-outs provided additional structure and clarity, which compared to the brainstorming stage were based on the author's own interpretation of users' ideas. Combined together, this fostered a sharing of different points of view, heavily influenced by participants' understanding of more conventional technologies. Incorporating elements of playfulness throughout, it is felt that this 'two-pronged' approach indicates the types of visual techniques that can help resolve associated barriers, by getting older people to more successfully conceive and then externalise their ideas.

In hindsight, given the prominence of the thesis to novel requirements gathering, it is important to emphasise that there was a strong onus in identifying what participants would want, rather than what they had suggested. This included the development of the interactive prototypes in

Chapter 7, where design ideas were very much based on this concept. A second paper prototyping stage (or equivalent) may have helped resolve some of the issues identified. However, this problem puts a significant responsibility on the researcher, to ensure participants are kept 'on track', and that all ideas remain 'user generated'.

9.2.2 Recommendations and future work

Given that the majority of methods and techniques were only implemented once, it is clear that further refinements would be necessary to improve their effectiveness. Examples range from the positioning of audiences during the Forum Theatre study, to encourage better communication, to modifying the drawing tasks in the brainstorming activity, in order to facilitate greater user involvement. One possibility, the development of an interactive research tool, could prevent the need for drawing altogether. Examples include the design and preparation of graphical components by users, by giving them the opportunity to change and rearrange details on-screen, while for the researcher, to record or log events. This could be done on a standard touch screen display, or more ambitiously using multi-touch surface interaction, with the possibility of manipulating physical, tangible objects using an infra-red (IR) camera and associated image processing techniques.

More widely however, it is essential to investigate other methodological approaches as a means of encouraging older users' to talk about their relationships with technology. Understanding how they can maximise their input in the development of innovative solutions associated with others in their age group, along with (perhaps) the biggest challenge, making sure these methods are suitable for 'all' older people, across different usage contexts. This brings into question the relevance of the usability engineering life cycle model that typically moves through a linear sequence of requirements analysis, design and evaluation phases, in which the elicitation of requirements from an end users perspective are seen to improve the structure of the organisation, primarily in terms of productivity and performance. In this thesis, having identified differences in users' conceptual models, there is clearly a necessity for an approach

that emphasises creativity, engagement, experience and aesthetic appeal, moving beyond the bland and over-simplistic interface models still associated with assistive technology.

Furthermore, given that usability testing and evaluation is (traditionally) done in a single session, this leaves little time to consider the early learning curves of users, least of all older people. In other words, by focusing upon users immediate experience to a set of selective tasks, over time, usability testing and evaluation fails to determine the extent to which such users can actually overcome difficulties, in becoming quickly accustomed to related interactive concepts. This is a critical issue given many (but not all) older people will demonstrate an initial reluctance towards using new technology, either due to personal characteristics, or other motivational factors, such as negative experience with modern technology. As a consequence, it is important to further investigate measures to help early learning strategies, as has been explored in the continuity theme of this thesis.

Having centred on both early and more focused requirement gathering stages, the long term aim of the research is to develop a theoretical framework exploring the whole design process, including more appropriate and refined formative and summative phases. Undefined, these include questions over how best to disseminate associated research findings in order that designers and software professionals demonstrate greater empathy and understanding towards heterogeneous groups of older adults. This is necessary to challenge the preconceived notions of the ‘older user experience’, by gathering appropriate data to inform and inspire individuals towards implementing far more creative and genuinely inclusive design solutions.

9.3 Constraints in working with older people

Directly related to Section 9.2, the second question specifically focuses on the issues of collaborating with older people, in order to attain greater understanding of the limitations of the methods and techniques applied.

Question2

What are the relevant constraints in working with older adults in the context of developing new applications?

In answer to this question, a number of limitations in working with older people have been identified. Some of these naturally relate to previous research findings, as reported in the literature review in **Chapter 2**. These include a lack of confidence and familiarity in using digital technologies, which can conflict with understanding and estimations in their ability to use new systems. However, the literature review finds that, while many HCI studies like to group and emphasise older adults as poor technological users, rarely is the generational factor explored. Rather, in reiterating user heterogeneity, the studies in this thesis have demonstrated that many of the volunteers were articulate and willing to embrace new forms of technology, given their appropriate representation.

9.3.1 Discussion

An overriding issue identified from this thesis has been the extent to which (fragmented) conceptual understanding of familiar technologies can influence older adults' interpretation of new systems. Although the issue of mental models is not new to computing, little research has examined how analogous thinking of electro-mechanical devices and other day-to-day procedures can influence the interpretation and design of new technologies for older people. Returning to the Forum Theatre sessions (**Chapter 5**), specifically for computer users, a rejection of new digital television applications were based on their (assumed) similar functionality to the desktop PC. These issues further related to a 'mix up', or mismatch, of operational procedures as reported in **Chapter 6**, in which the 'TV communication system' was heavily influenced by the perceptual and functional understanding of the telephone (despite being a digital device), while the video-cassette player influenced behaviour with the video messaging application (see **Chapter 7**). In each case, it is clear that capturing knowledge, values and skills related to traditional technologies could be a critical means of exploring new

design directions and possibilities for older adults.

A major challenge for this thesis has been the deployment of methods to encourage participants to move beyond their 'comfort zone', in terms of what they know, or are familiar talking about. Encouraging individuals to verbally discuss ideas with limited knowledge of digital television proved highly problematic within one-to-one interviews and focus groups. However, as previously reported, this was also evident in the paper and interactive prototyping sessions (**Chapters 6**, **7** and **8**), where individuals struggled to expand on the examples given.

This research has identified further limitations that are rarely reported within mainstream HCI literature, but could potentially, if unacknowledged, bias and distort further research. While they do not apply to all older adults, beyond those previous constraints identified in **Section 2.5**, they include:

- **General observations:** These relate to variations in group dynamics, from overly agreeing, or conforming to the opinions of others (including the facilitator's), to, at times, contradicting previous remarks made (usually unknowingly). This included the negative stereotyping of other older people's understanding of technology, in describing design preferences from the perspective of a third person, known or imaginary.
- **Limitations of reasoning:** Prior knowledge of known technologies and procedures had a strong influence in the understanding of new applications. Analogous models to more familiar systems created a strong demand for similar types of form, or functionality. However, a lack of sufficient comprehension to these known systems meant users were reusing, or reciting disjointed knowledge, in an attempt to make direct comparisons to new concepts, already tainted by previous misunderstanding.
- **Validating findings:** Versatility was found to be vital in providing the necessary reassurance (at least initially) for some participants to persevere within tasks. Without this experience, there is a fine line between prompting to aid, compared to explicitly

telling an individual what to do. However, it was often the subtle differences in encouragement and questioning that maintained perseverance. This often accounts for inconsistencies between what was observed, compared in retrospect, to the users' own subjective interpretation of their performance.

9.3.2 Recommendations and future work

The question of what kind of prompts can be given to older people to expand their abilities and help them gain new insights into the possibilities of new technology requires further research. Misunderstandings of modern technology could be seen as a constraining factor in working with older adults. However, such confusion could also be considered as a form of liberation, in freeing up our interpretation and thinking about how technology should behave, or be tailored towards the diverse experiences of older generations. This is not to say that domestic technologies like television should directly function like a telephone, but it seems likely that there may be similar metaphorical features that could encourage better understanding in the learning of new applications.

Given the nature of the research findings, it is very difficult at this stage to give detailed recommendations or guidelines. Issues like the forgetfulness of layouts, or applications, can be considered as a natural consequence of ageing and cognitive decline. Additionally, contradicting and conforming opinions in requirements and evaluation phases are commonplace within other qualitative methods (e.g. focus groups), which in many respects relate to conducting good research practice. Nevertheless, based upon the evidence presented in this thesis, certain improvements can be made, whereby the importance of direct experience in working with older people should be communicated. This should not only be explained in terms of establishing a good rapport with volunteers, enabling them to become more relaxed, or open minded to new design concepts, but also in allowing the researcher time to valuably learn from early mistakes, in the experimentation and fine tuning of techniques. This requires exploring approaches that can help triangulate results, given in the case of this thesis, a solo study is likely to have drawn

very different, and to some extent, unrepresentative conclusions.

9.4 Towards a new paradigm of interaction for DITV

Having established application areas of interest from earlier studies, the third and final research question directly addresses the design process of how to develop more appropriate models of interaction for DITV suitable for the target group of this thesis.

> Question3
>
> *What methods can be used with older adults to evaluate the intuitiveness of proposed design approaches to DITV services?*

Moving from analogue to digital broadcasting is resulting in the increasing complexity of television viewing habits for many, demonstrating it is more likely to fragment and divide, than inform and unite (this is illustrated by participants' uncertainty of the DITV domain [e.g. see **Sections 4.4.1**, **5.4**, and **5.4.7**]). As previously reported in **Chapter 3**, the ignorance towards older people as a diverse audience group, is currently fostered by a myriad of factors, some of which relate to technical problems in using low specification STBs limiting the design of available content, while others to the lack of consideration to older people as relevant stakeholders. Supported by user feedback throughout **Chapters 4-6**, the motivation for this research question was based upon the importance of successfully being able to assess the impact of more dynamic navigational styles in developing new types of input device, and associated interactive content.

9.4.1 Discussion

Chapter 7 began to directly address this question through exploring more traditional forms of empirical evaluation in which older participants were asked to compare four different navigational styles, one of which was based on the visual design of current interactive services, while the other three were developed around the concept of continuity as a means of

emphasising change in the state or movement of a graphical object.

As an outcome of the prototypes designed, for the standard layout, analysis of results revealed the difficulties of using drop-down and scrolling menu components, as individuals struggled to complete tasks independently. In general, with the exception of the *Transparency* layout (see **Section 7.4.3.2**), the careful compositing of graphics and animated effects were seen to aid the spatial awareness of information, in linking between related screen objects.

Extending the continuity concept further, **Chapter 8** investigated the effects of different forms of animation (compared to static movement) through the direct manipulation of two-dimensional objects, and fixed viewpoints in a virtual space. Building on the findings from study 4, an analysis of results revealed a number of factors, such as task complexity, transitional speed, duality of movement and graphical quality, which are likely to have a variable impact upon the understanding of animated effects. Encouragingly, the use of animation was praised for bringing clarity and assurance to the completion of tasks, as both studies indicate a strong case for alternative navigational styles, more suitable to this target group.

Underpinning these findings, a number of issues in working with older adults were further identified. Notably, the conflicting roles of the author, as a facilitator in attempting to stay impartial, while at the same time gently steer the elicitation process to encourage and clarify answers without explicitly advocating what to do. Far from an orthodox situation, as previously reported in **Section 9.3.1**, these studies identified the 'grey area' between aiding someone to persevere within a task in order to obtain richer data, compared to overly directing and subsequently influencing their decisions. This was backed up with a number of examples demonstrating the array of variability amongst participants, ranging from those who wanted a considerable amount of confirmation early on in sessions, compared to others who were far more assertive in their actions taken. Across the spectrum of users, these issues were further complicated by a number of instances where participants were found to contradict themselves,

demonstrating noticeable discrepancies between how they assumed they performed, in comparison to what they could actually do. These differences were often thought to be due to a lack of familiarity with the navigational layouts, rather than design *per se*.

9.4.2 Recommendations and future work

Overall, while the evaluation methods applied were more conservative to the early requirements gathering studies in their experimentation, as part of a collaborative design process they were nevertheless substantially useful - both in terms of accounting for differences in opinions, attitudes and feelings towards the design and user interaction of the prototypes developed, as well as determining the extent to which participants could assess the choices available to them.

As part of this process, informal warm-up activities like the photograph sorting exercise seemed to strategically help clarify the structured procedure. Building on older people's familiarity with using physical images, as an easing mechanism to the on-screen tasks, the 'hands on' aspects of this activity reflected the tacit and playful qualities of building paper prototypes reported in study 3. By contrast, exploring in more detail, issues related to the prototypes themselves, some individuals struggled to utilise prior knowledge in a manner that critically evaluated more novel design solutions. A recurring theme throughout this thesis, in order to bridge into the unknown, the importance of structured observation must be embellished by an array of experimental methods that will help elicit more successful results. In each case, it is clear that verbally discussing aspects of the prototypes tested is not enough.

By the same token, given the nature of the facilitator's active role during user evaluations, while careful attention was paid to the types of language and descriptive questioning used, by default, their presence will, by its very nature create a certain amount of bias. Therefore, to better determine how well participants can independently persevere within a set number of tasks, more controlled studies are required in which the facilitator's role is effectively removed. At the same time, further evaluations have to consider the potential effect of moving beyond the clinical

boundaries of a usability laboratory towards real world, *in situ* testing. To help orientation, this could include the possibility of sending background or preparation material prior to the start of sessions. Unfortunately due to the logistics of time and financial resources, this was beyond the remit of the thesis.

By contrast, given the significant amount of time taken to develop new navigational strategies, from an interaction design perspective, the impact of the continuity concept, while having demonstrated some encouraging results, needs to be further investigated to validate its appropriateness when designing for older adults. As such, further research is now required to determine how different forms of visualisation could help build user confidence, learning and sustained understanding in interacting with associated forms of digital media. Accordingly, more rigorous studies are required to determine the cause and effect of a more concise set of animated tasks. This could also include the analysis of independent measurements such as the impact of spatial ability (and other relevant cognitive and mobility measures) and prior computer knowledge in aiding navigation.

Questions also remain about the extent to which metaphorical features, linked with properties (and associated constraints) of physical objects can aid in the manipulation and comprehension of 2D graphics (including their feasibility to be customised by end users). At the same time, it is questionable the extent to which these navigational concepts would be suitable to other domains, and forms of technology, particularly those devices with a limited set of functionality. This includes the extent to which the continuity concept could be used like the equivalent of animated demonstrations, or a 'training wheel' approach, which typically reduces the amount of functionality, in order that on-screen information can be adapted to novice learner needs. However, in stressing the remarks of Hawthorn (2005) who describes the danger of design simplicity in "*blind*[ing] *us to the level of application complexity that older users are capable of succeeding with"*(p.1), such approaches need to be carefully considered as 'stepping stones' to aid in the implicit learning of more advanced non-desktop features. The related and ongoing

issue of the implementation of *any* approach to 'switching' from novice to expert modes for an interface remains open.

In exploring the roles of social applications, questions remain in terms of how older users would accommodate the exchange of much larger and more complex sets of data. This could involve the annotation and indexing of different forms of digital information. On the other hand, there is also the question of exploring new types of application that go beyond multimedia sharing, towards other aspects of social use. For example, there is a necessity to improve the accessibility of broadcast content (e.g. subtitles, audio description, etc.), which for many older people will form a basis for much television usage.

In acknowledging that the interactive prototypes were designed around the simplification of a standard remote control, there are also likely to be further adaptations of this device that may well prove equally, or more successful. In having focused on a 'dual interface' approach, which considers both the input control and on-screen interaction (critical in the development of DITV applications), many questions remain towards the mapping of more complex functions and associated screen prompts and memory cues. This is particularly important given that there will be certain functions that will not have a known 'real world' analogy, but nevertheless will require a high level of transparency to ensure their learnability. A good example of this was the 'video messaging' application reported in study 4, which identified a number of usability constraints in terms of the direct mapping of handset commands to on-screen graphic controls (lacking explicit instructions and visual feedback). Consequently, as an alternative approach, these navigational issues may be overcome by investigating more intuitive interaction methods, self-adapting to the individual user.

Beyond the conventional handset approach, it now seems highly plausible to explore the increasing bandwidth available between other state of the art technologies and the associated STB platform, to include the use of other relative and absolute pointing devices, with integrated

features like accelerometers for tilt-based control (e.g. the Nintendo Wii). As a hybrid device, this could incorporate the stable and high pointing precision of a PC mouse, with the traditional living room comfort of a remote control, the sustained use of which will bring into question ageing factors like reduced flexibility, hand grip and muscle strength. Therefore, in addition to ensuring appropriate force feedback and hand posture as a consequence of prolonged exposure, this device will have to accommodate for variations in muscle load, trembling and fatigue.

To compensate the option of using a physical device, there are also alternative interactive possibilities of integrating speech recognition (with limited vocabulary), and computer vision techniques that apply hand gesture or gaze detection (namely through the use of eye tracking equipment). However, to work in a domestic setting, such recognition-based systems will have to be fairly robust, able to run on relatively low computational power in an STB, and accommodate for delays in system latency. With all forms of interaction, there is also the question as to what type of 'cursor control' (or equivalent) would be most suitable, and how these devices will support alphanumeric input (including possibilities for predictive text as reported in **Section 7.4.5)**.

9.5 Summary

As HCI extends beyond concepts of usability and associated workplace principles of productivity and efficiency to encompass aspects of enjoyment, pleasure, engagement and play, significant challenges remain in terms of designing for an increasingly diverse and ageing population who have grown up with different types and associated forms of interaction. Converging domestic media means that ICT technologies like television, traditionally perceived as a passive form of entertainment, are significantly changing. This thesis has focused on the early requirements gathering and evaluation phases of new digital interactive television applications, predominately for those people with limited technological experience. A series of user-centred design methods were developed to gather ideas from older adults, identifying both constraints and challenges in designing for both age and generation differences. Interactive

prototypes were built and tested on the theme of continuity. The results illustrate the necessity for new interactive approaches to aid in the development of information appliances in the home. At the same time, through the methods applied, arguments are put forward to encourage researchers and practitioners to reassess the techniques used to embrace the mindsets of many older adults, in understanding their importance for developing more successful computerised artefacts appropriate to their age group.

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Appendices

Appendix A: Press release (January 2006)

Digital television - opening up possibilities for the non- 'MTV generation'

Television is changing - and for many the arrival of new technology will be met with something akin to dread as they have to adapt to more complex and technical systems just to access their favourite programmes.

Now researchers at the University of Dundee are embarking on a new project which will investigate ways of making it easier for more people to make the most of this new and unavoidable - but potentially beneficial - technology.

Research fellow Dr Alex Carmichael and Mr Mark Rice, a PhD student, both based in the Division of Applied Computing at Dundee, are to explore how the fear of change can be reduced by making things much simpler to use.

The Government recently announced that 'Digital Switchover' of all television broadcasts across the UK will be completed by 2012. This means that anyone who has not invested in the appropriate digital equipment by that time will receive no television services.

It appears that many people are unaware of this 'switch off' aspect of 'switchover', as the present analogue TV signal will disappear. There is also a similar lack of awareness and some confusion about many other aspects of 'digital' and 'interactive' television, particularly among those who don't feel part of the 'MTV-PDA-MP3-texting-24/7-3G' generation.

"Unfortunately a lot of 'modern technology' tends to be designed by relatively young and technically savvy people, effectively for other young, technically savvy people," said Dr Carmichael, whose work ties in with the wider i~design project in which the University is heavily involved.

"While many not-so-young and not-so-technically savvy people can manage to make some use of technology designed this way, others will face real difficulties along with the accompanying frustrations, and some will find it simply impossible".

One important implication of the switch to digital is that televisions will become much more like computers. For many people this is good news as it gives them greater control and more choice. However, for others it means that using their television will become much more complicated and for some this could mean too complicated.

"We have to see how we can make things much simpler to use, particularly for those people who aren't particularly comfortable with using new technology," said Mark Rice, whose PhD project is looking into using digital television technology to help support more sociable activities, primarily for older people.

"Mostly this will involve relatively small changes to the design of the interface and remote control, based on the huge diversity of capabilities and preferences among the viewing public".

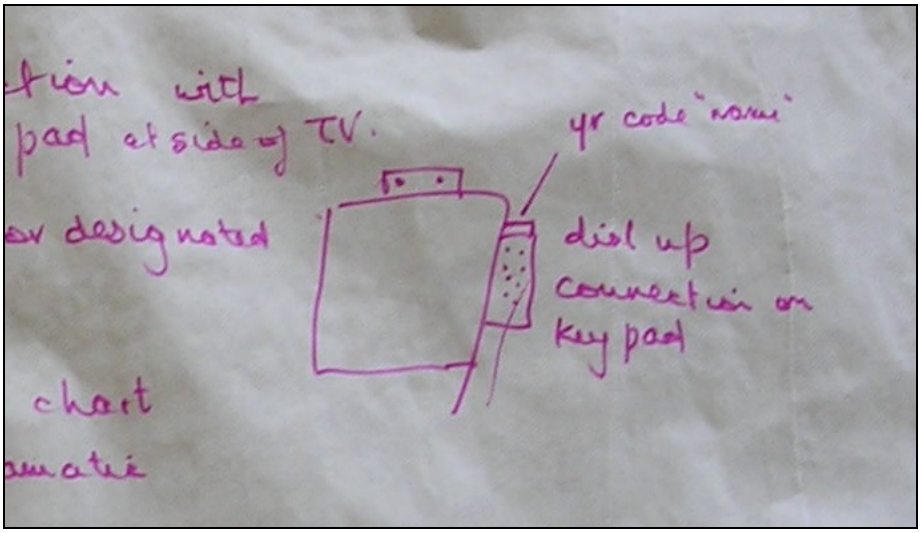
"We are also looking into ways of using the 'computing' power of digital television to support activities that are maybe more suitable for people who don't quite feel part of that 'MTV-PDA-MP3-texting-24/7-3G' generation."

Dr Carmichael and Mark are now looking for volunteers to help with their research between early 2006 and late 2007. Particularly anyone over the age of forty (no upper limit) who accepts the potential advantages of digital technology but whose experience with it tends to be more pain than pleasure.

Anyone who wishes to get involved with the research project should contact Mark and Alex on 01382 XXXXXX.

Appendix B: User-generated sketches

Example 1 - The attachable phone



Mrs H: Dial in. Now that might be a thought, as one of the familiar things to add to your television. Everyone's quite familiar with a telephone dialling pad. Now if you had a little vertical dialling pad people could dial the person they wanted to speak too.

Author: Ah, OK.

Mrs H: Now that would be, obviously the technology would involve logging in, but in fact that is what they would do, now they could cope with that. So, dial up a connection.

Mrs S: Or something with just your own name, something really, really simple that they would always remember.

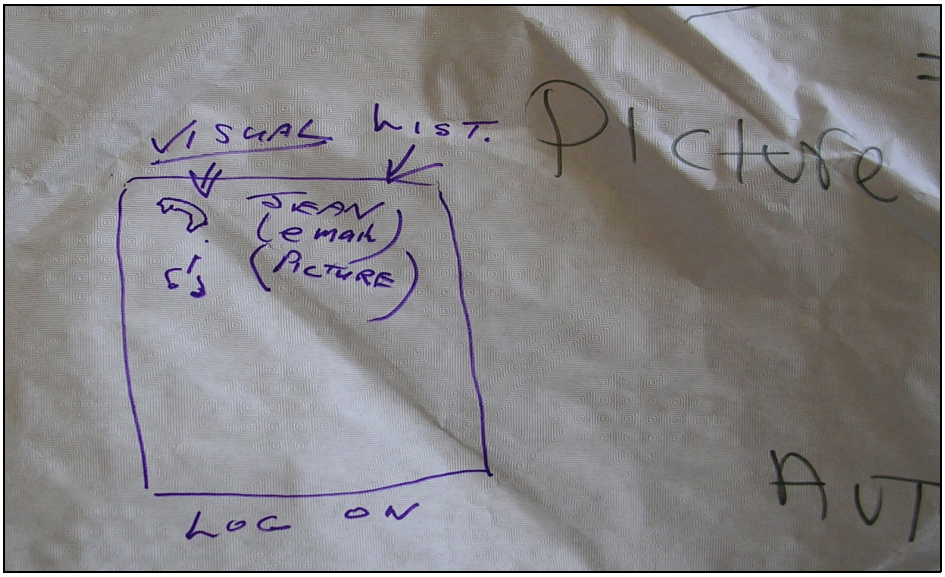
Author: Right.

Mrs H: And again it could be rigged so that just as you key in a number to your telephone, your mobile phone, it could be that Auntie Massey is number one, and all you do is press one, but in fact it will then have been keyed that will be the dialling through code for Auntie Massey. And number two will be the dialling through code for your grandchild, whatever. So something like that would be very simple, but yet familiar.

Author: OK, so what you are proposing is something like a, something to the telephone.

Mrs H: Yes, you could have it attached to the television on its side.

Example 2 - Checking availability



Mrs P: Right, there's the box. And they come back from their holiday, or whatever, and they log on, right. Let's put the log on, I'm terrible [*drawing*]. Log on right. And you would have some kind of symbol. What could you have, say, that's a phone, supposed to be. That's a phone [*referring to the drawing*]. And that would come up immediately, and say Jean phoned. Or, not even necessarily Jean, but her symbol, or email. Or her, wouldn't be her email, whatever you like to call it. Or, even her picture.

Author: Ah.

Mrs P: You know, whatever symbols you decide to use for this system, they have to be visual. Right.

Author: On this list you would have the person's name, the email address...

Mrs P: Yeah, exactly.

Author: ...and may be the messages.

Mrs I: They wouldn't even have, if you were away for the two week, it wouldn't have to be a 'message', just coming up with the context, contact back.

Mrs P: That's right, that's what I was thinking. It would be more in the lines, like your email, you can pick it up, and think, so and so sent me, whatever. So I would think that mostly when you log in to see this visual thing, phone, whatever, you want to use, it comes down with all the people whose tried to get in contact with you. Right, then it’s up to you.

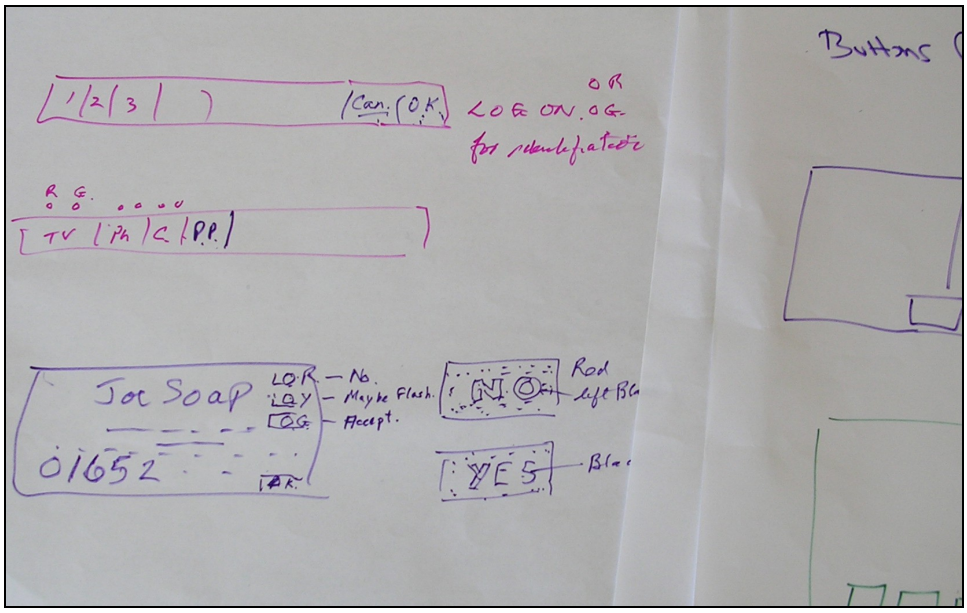
Mrs I: Whether you want to reply, or just want to meet them.

Mrs P: For instance you talked about a doctor...

Author: Yep.

Mrs P: ...well it may well be that he's found something that he needs to tell you, and that's very important, you would need to. So you could have, what's for a doctor, stethoscope. How do you draw a stethoscope, I don't know. You could do that, and know right away your doctors getting in touch with you.

Example 3 - The PowerPoint concept



Mr D: ...but if in fact you've activated your TV, and as I say, if you've activated your PowerPoint thing and you've got these numbers, then the numbers are there, on the screen. Now, the fact that there's the person's name, you've gone through your PowerPoint you've got to the person you want to contact, you've know you've got to read their name on the TV...

Author: Yeah.

Mr D: ...and there's the telephone number. Now, that number is sitting on the screen, now. I don't know, a lot of these CCD's [*unknown acronym*], what they can be wired up to do, because I never worked on them. But the fact that the number is sitting there on the screen, could that number then, by just pressing a button, your through to that number.

Author: Yeah, yeah. From a design perspective, would you expect the number, if you had a card of the person, would you expect that number to be on that card?

Mr D: Yes, and quite large. I would think that the card, you know would be [*drawing*], Joe Soap...

Author: Yeah.

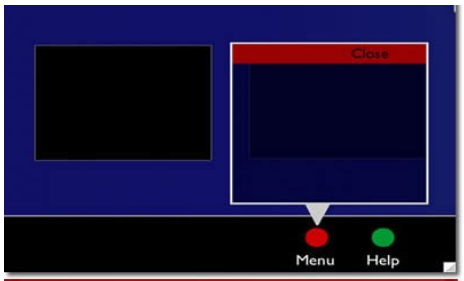
Mr D: ...and his address, whatever it was, and then his number, '0-1-6-5-2', etcetera.

Author: OK.

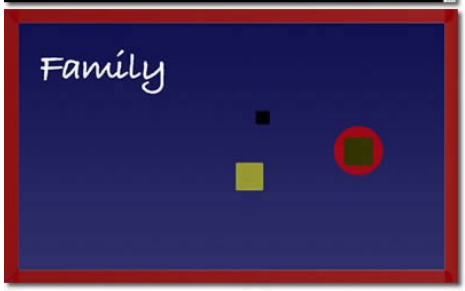
Mr D: And it could be in a dedicated box. Now, whether in fact these could actually, say, have an OK button, or something like that, here, to activate. Now, you have to be able to press these. Hum, and then, check that they are correct, and press the OK. Because one of the troubles about all of this, is, especially for older people they'll make mistakes. And you may even need a cancel button.

Appendix C: Examples of early interactive prototypes for study 4

Variations of the remote control design



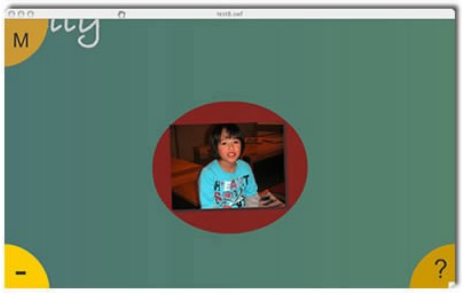
prototype 2



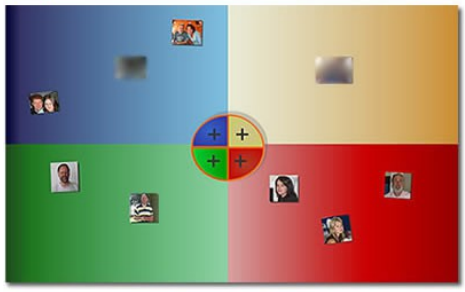
prototype 5

prototype 6

prototype 12

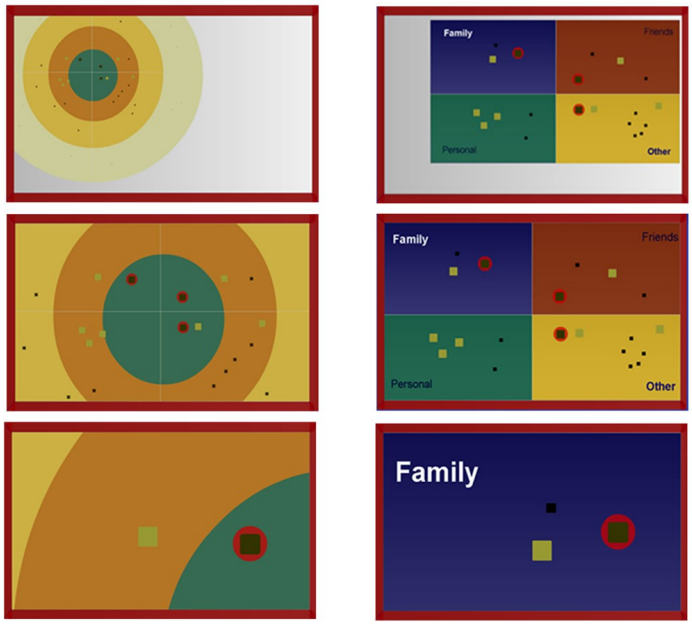


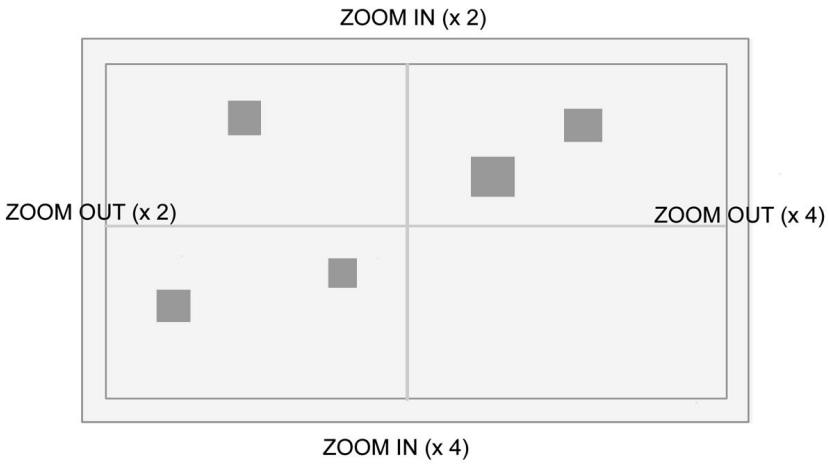
prototype 13



prototype 15

Early versions of the screen prototypes



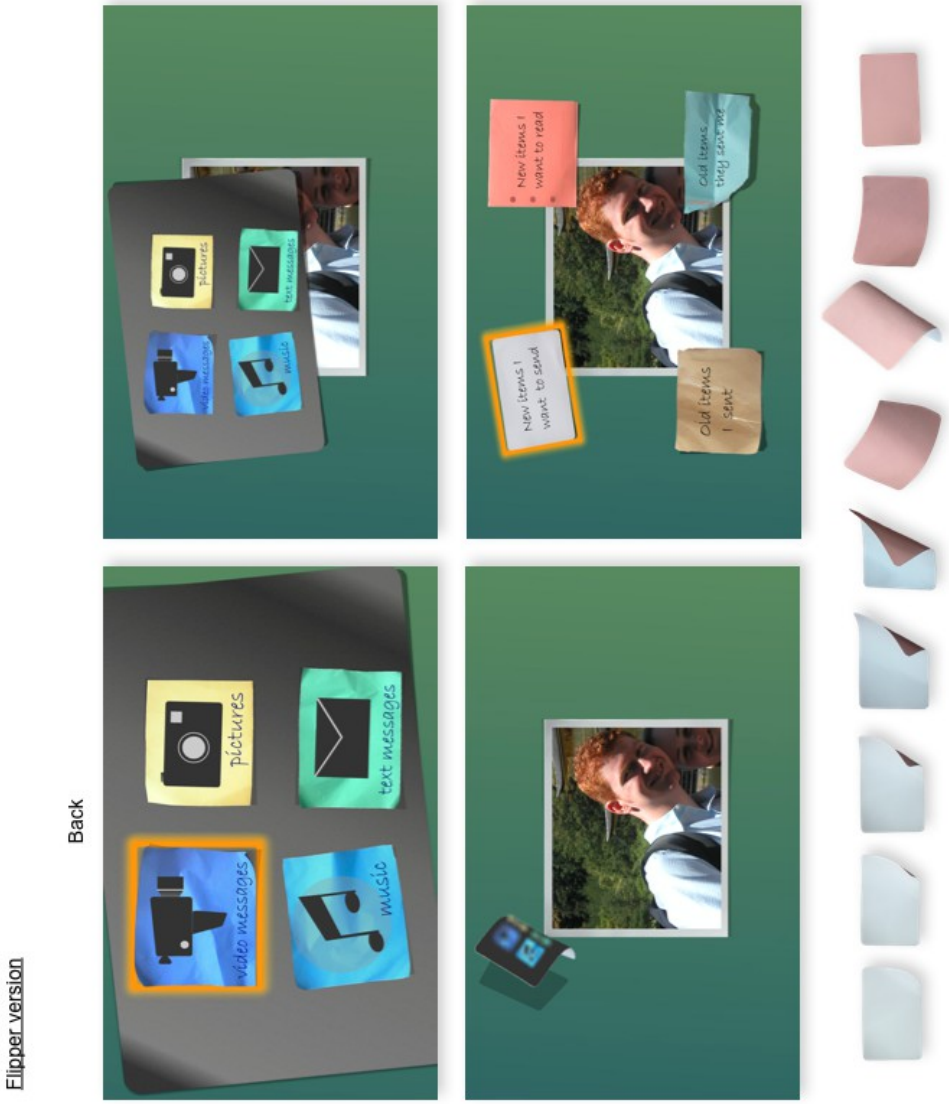


Early prototype versions (6 & 7)

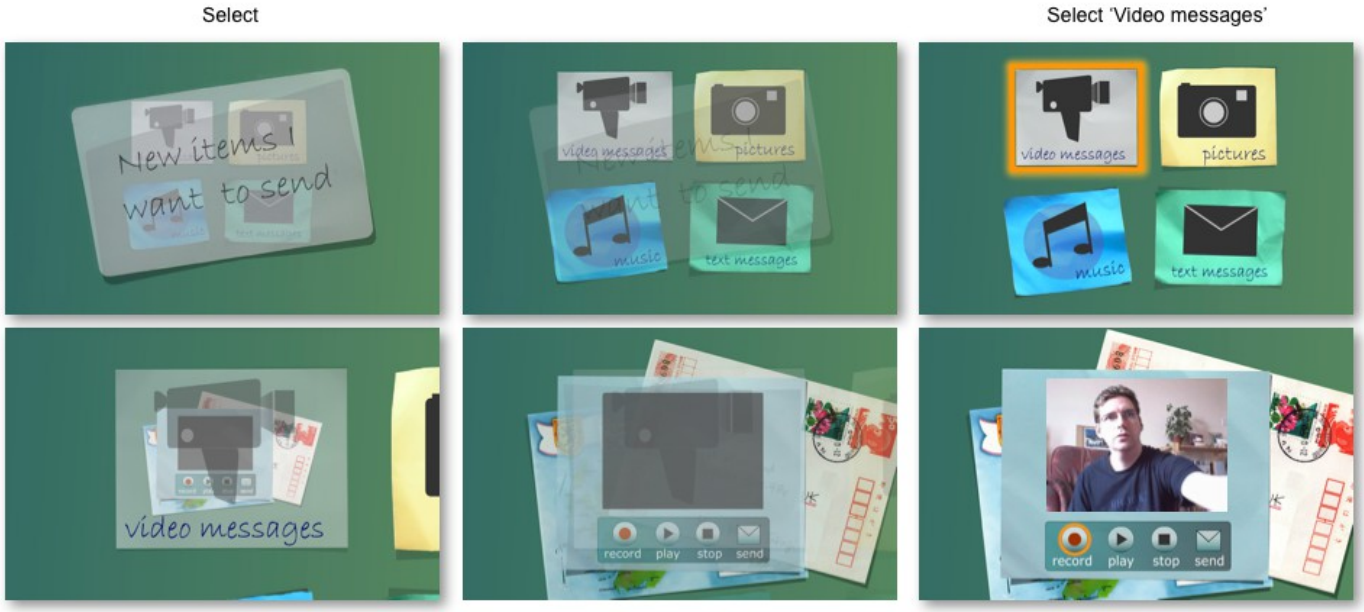
Description:

- pressing a red margin on screen changes the magnification of the graphical content;
- the small squares represent individual messages, with those flashing red, new and unopened;
- variations in colour signify the type of message (black, video message; beige, text message);
- the size of the message indicates when it was received (e.g. the smaller the size, the older the message);
- to aid in the organisation of content, messages are separated into different coloured regions.

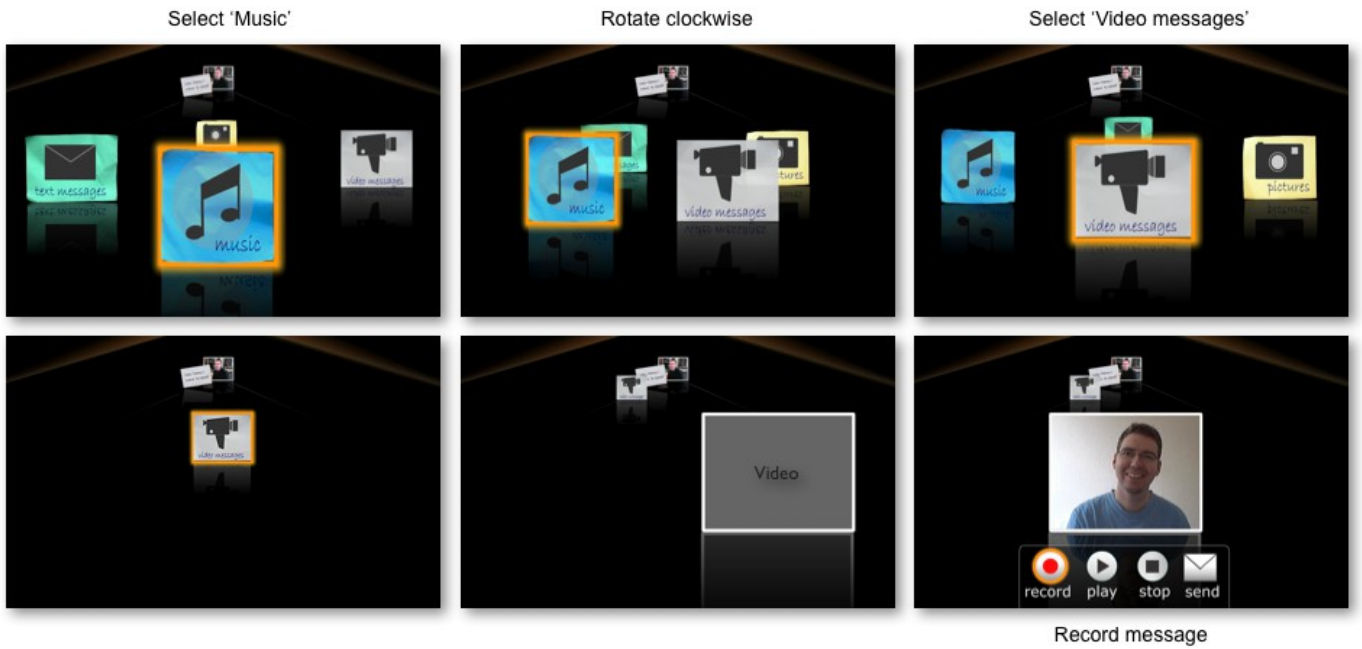
Appendix D: Graphical layouts for study 4



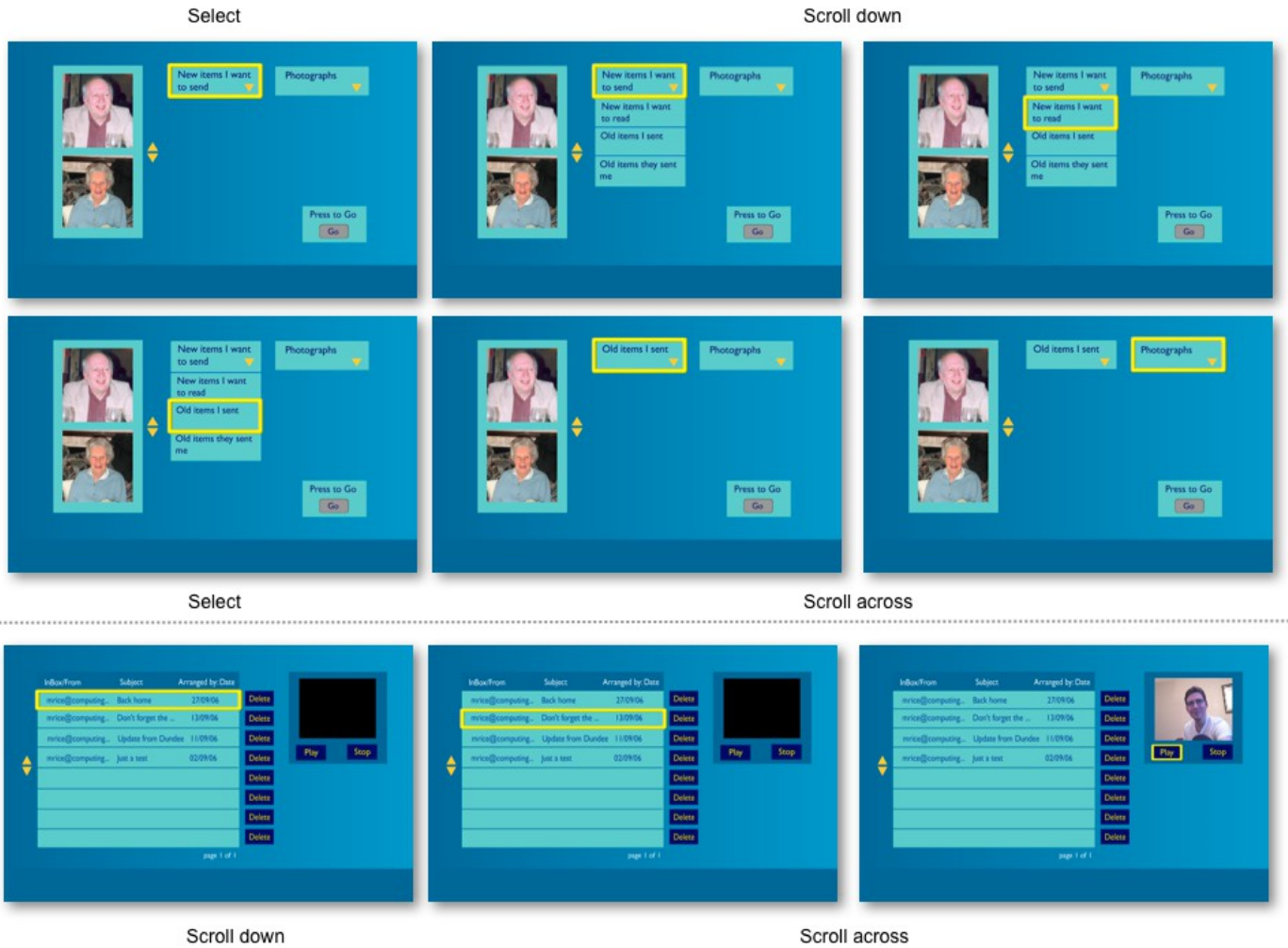
Transparency version



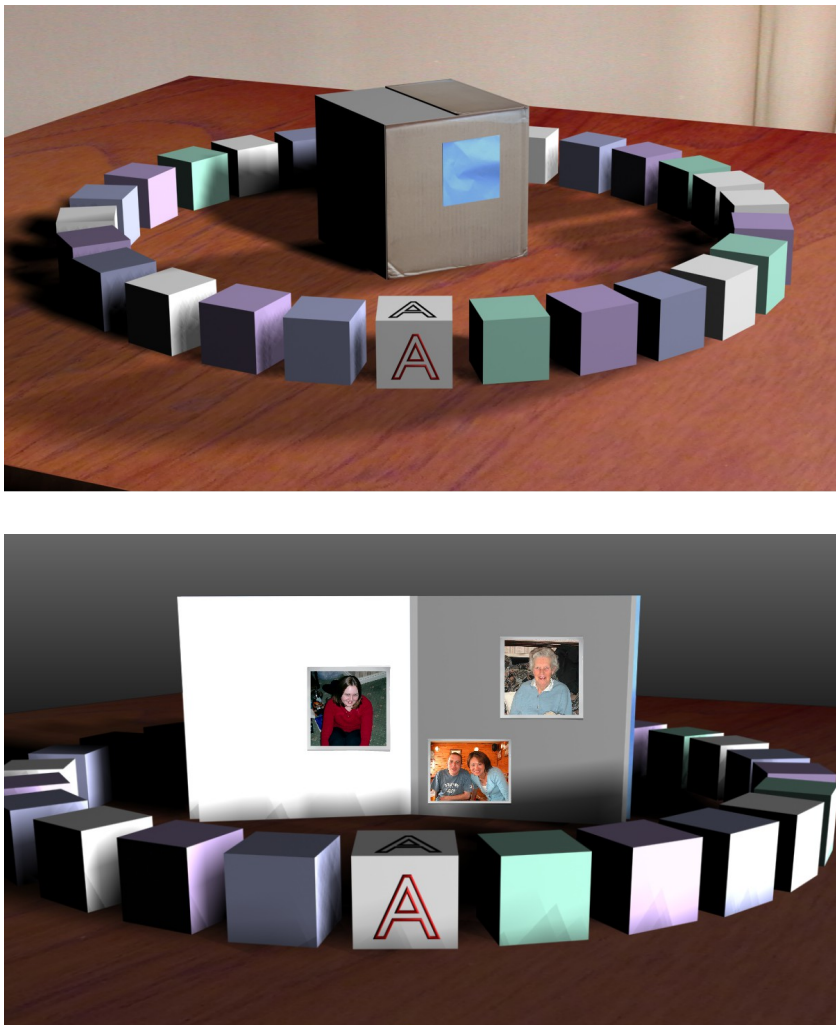
Carousel version



DTV version

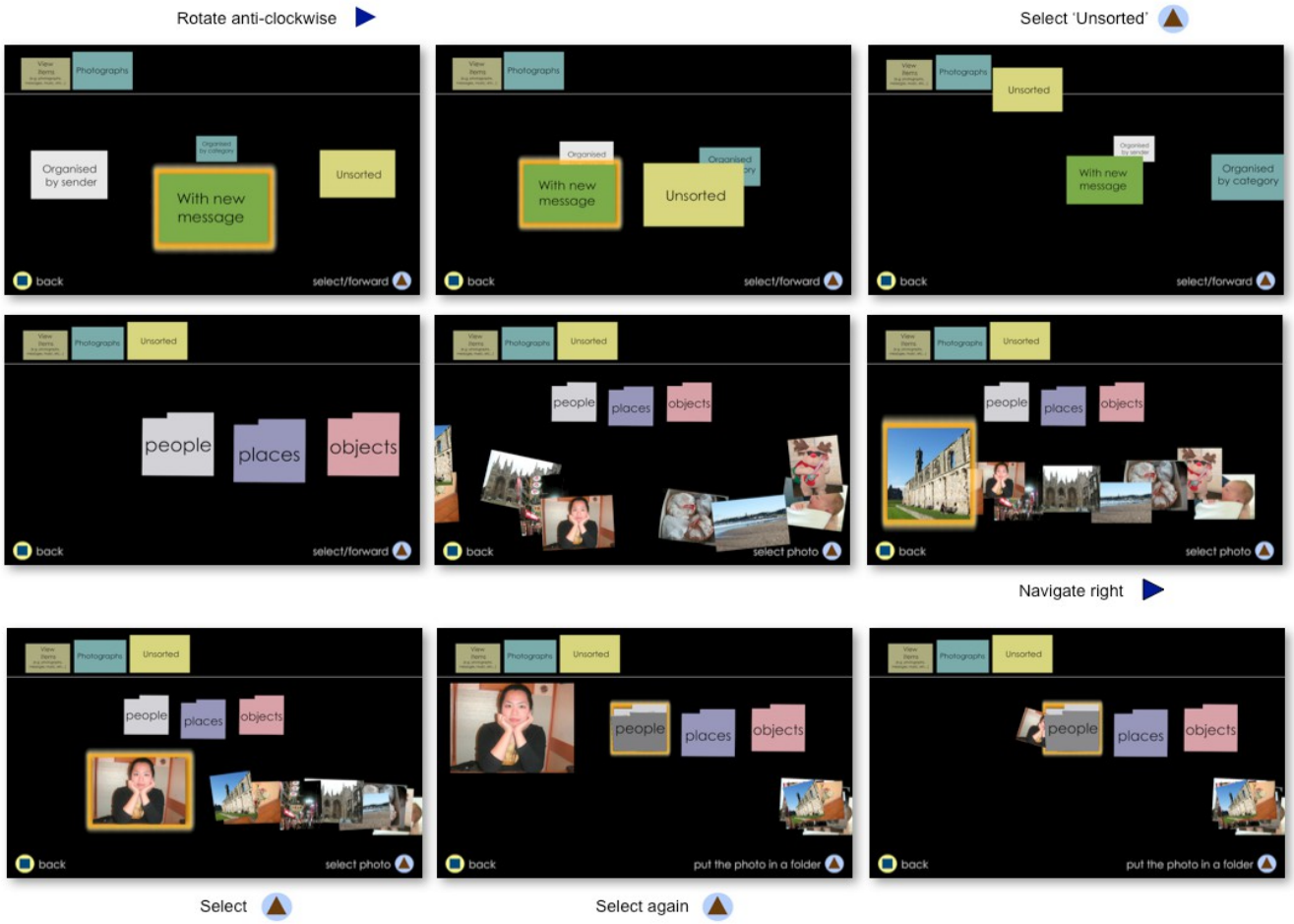

Select
Scroll down
New items I want to send
Photographs
Press to Go
Go
New items I want to read
Old items I sent
Old items they sent me
Select
Scroll across
Scroll down
Scroll across
Play
Stop

Appendix E: Graphical layouts for study 5

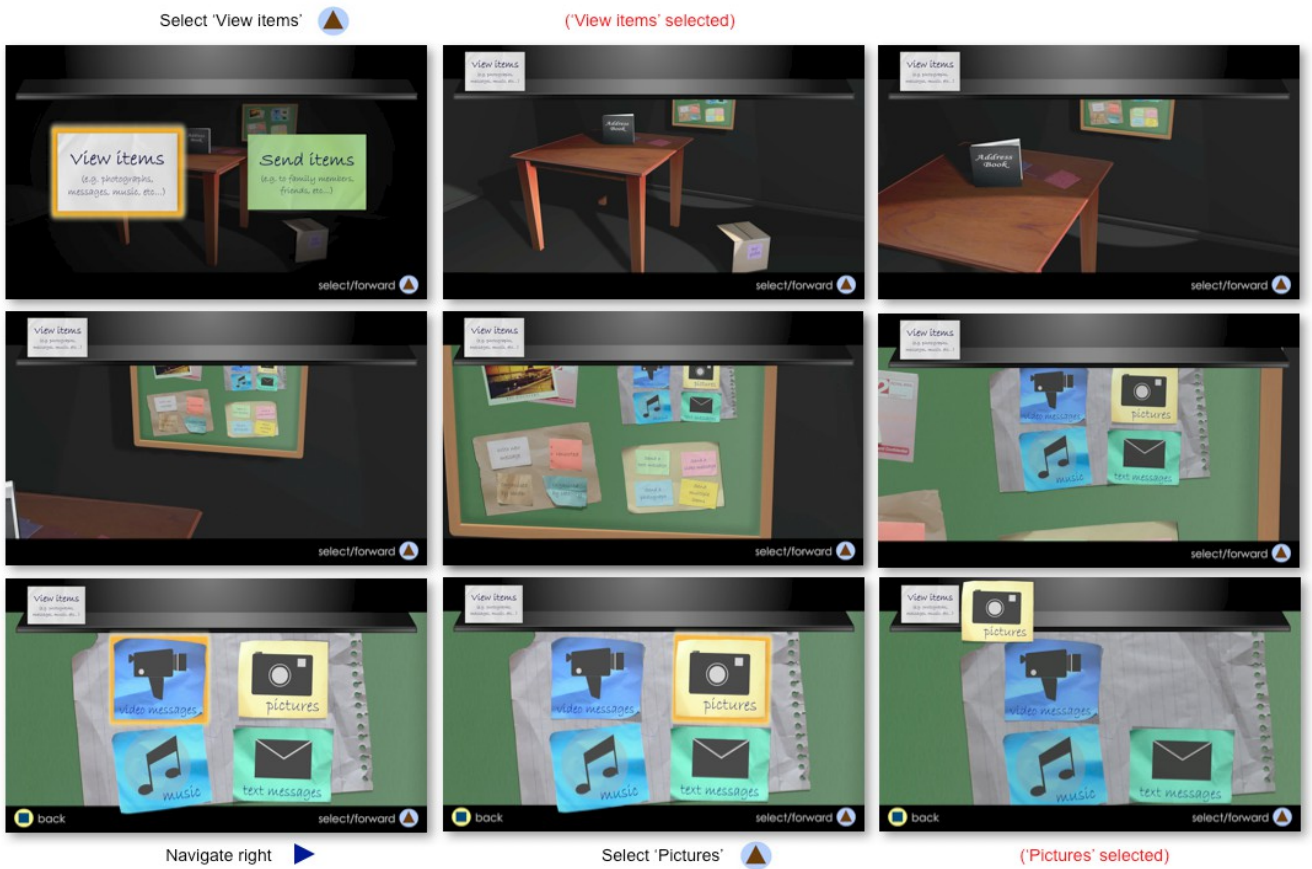


Examples of early variations of the address book concept

Abstract Continuity



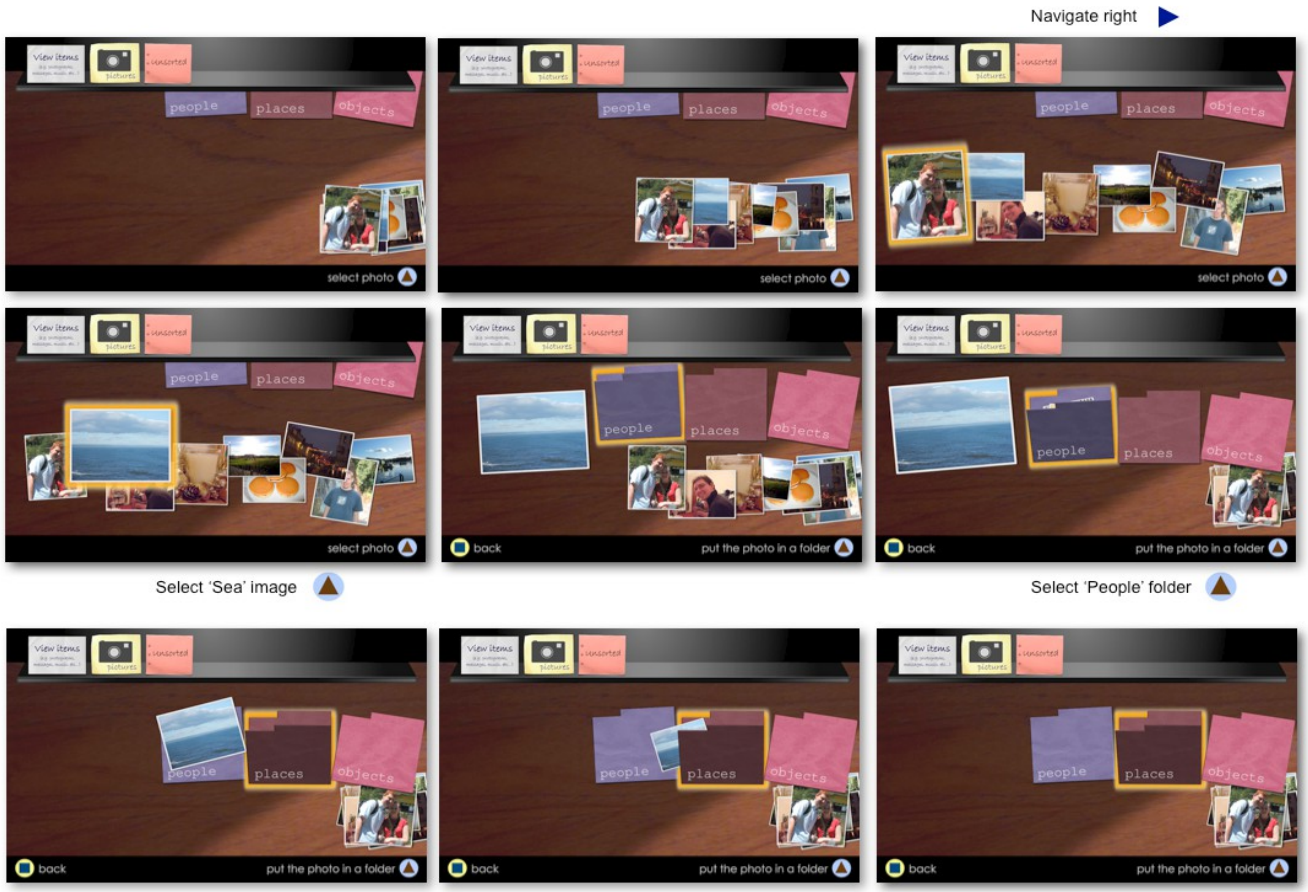
Realism Continuity (part 1)



Task: To organise a small set of photographs

Realism Continuity (part 2)

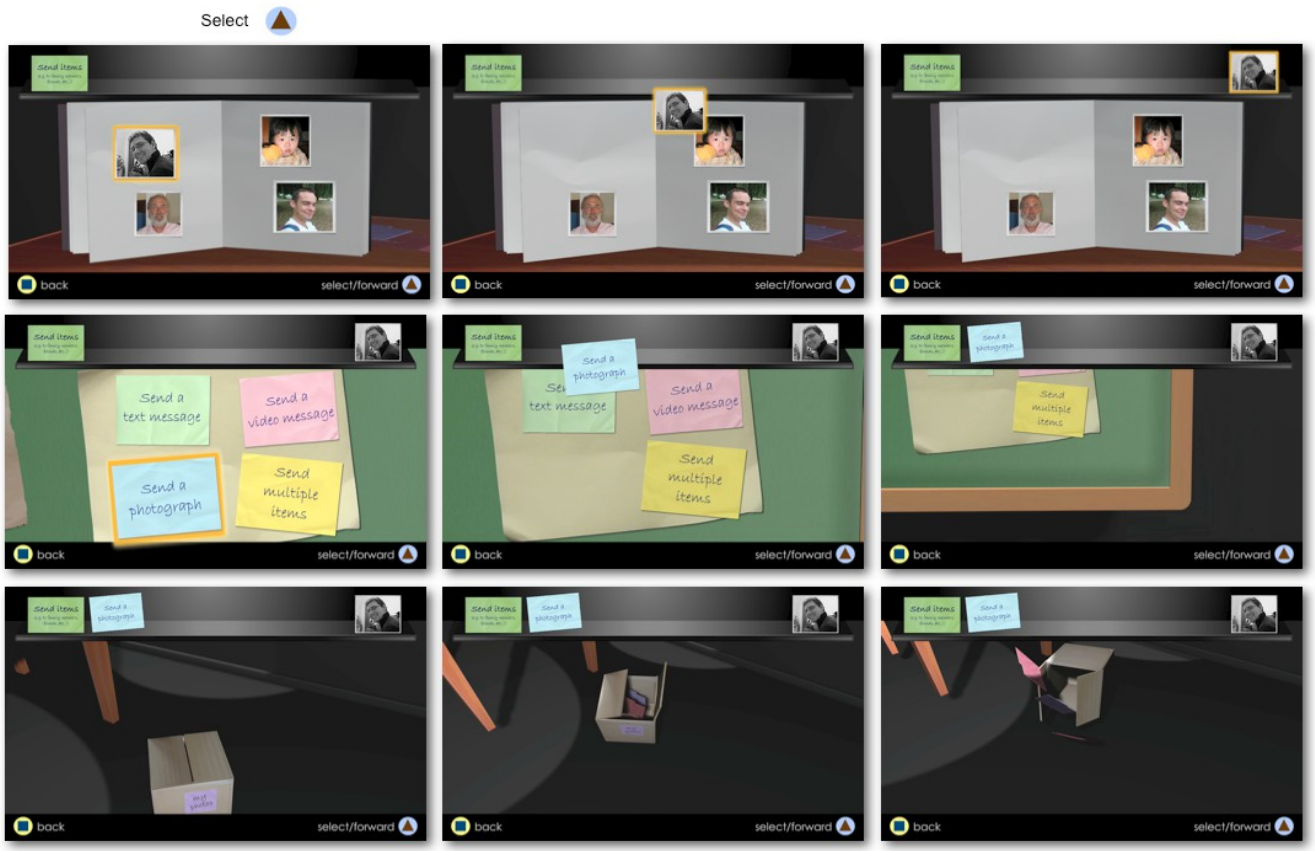
Realism Continuity (part 3)



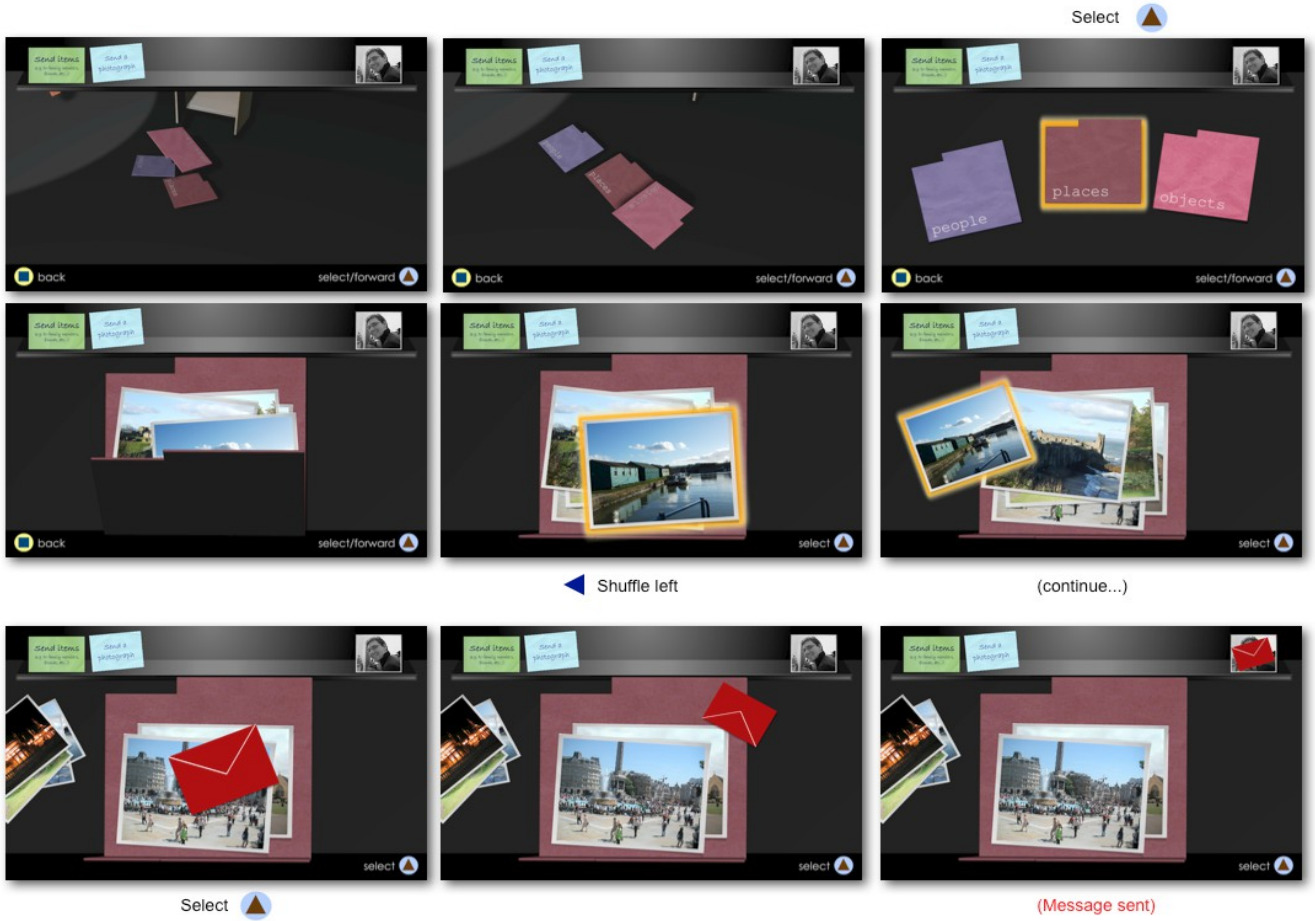
Realism Continuity (part 1)

Task: To find and send (in this case) one contact a photograph

Realism Continuity (part 2)



Realism Continuity (part 2)



Appendix F: Descriptive summary of study 5

Variable	Total number of distributed errors per layout order					
	Valid N	**Median**	**Minimum**	**Maximum**	**Percentile 25.00**	**Percentile 75.00**
Layout 1	18	23.50	5.00	60.00	10.00	36.0
Layout 2	18	7.50	1.00	32.00	4.00	15.00
Layout 3	18	7.50	0.00	33.00	2.00	12.00

Variable	Task distribution of errors per layout order					
	Valid N	**Median**	**Minimum**	**Maximum**	**Percentile 25.00**	**Percentile 75.00**
Layout 1 Task 1	16	8.50	1.00	31.00	5.500	14.00
Layout 2 Task 1	16	3.50	0.00	18.00	1.000	6.00
Layout 3 Task 1	17	0.00	0.00	11.00	0.00	3.00
Layout 1 Task 2	16	11.00	2.00	52.00	7.50	27.00
Layout 2 Task 2	16	5.50	1.00	16.00	3.00	10.00
Layout 3 Task 2	14	7.00	1.00	33.00	2.00	11.00

Variable	Total number of distributed errors per layout type					
	Valid N	**Median**	**Minimum**	**Maximum**	**Percentile 25.00**	**Percentile 75.00**
Realism Non-Continuity	18	9.50	1.00	60.00	2.00	32.00
Abstract Continuity	18	14.0	3.00	45.00	7.00	18.00
Realism Continuity	18	8.50	0.00	33.00	5.00	21.00

Variable	Task distribution of errors per layout type					
	Valid N	**Median**	**Minimum**	**Maximum**	**Percentile 25.00**	**Percentile 75.00**
Realism Non-Continuity Task 1	16	3.00	0.00	16.00	0.00	7.00
Abstract Continuity Task 1	17	4.00	0.00	31.00	3.00	11.00
Realism Continuity Task 1	16	1.00	0.00	15.00	0.00	6.500
Realism Non-Continuity Task 2	16	9.50	1.00	52.00	2.00	25.50
Abstract Continuity Task 2	15	8.00	2.00	16.00	5.00	11.00
Realism Continuity Task 2	15	8.00	1.00	33.00	4.00	11.00